Progress Report

Research Grant: NsG-489

September 1, 1965 - February 28, 1966

The Effects of Isolation, Sensory Deprivation, and Sensory Rearrangement on Visual, Auditory, and Somesthetic Sensation, Perception, and Spatial Orientation

Sidney Weinstein, Ph. D.

Departments of Rehabilitation Medicine & Neurology
Albert Einstein College of Medicine

Progress Report

Research Grant: NsG-489

September 1, 1965 - February 28, 1966

The Effects of Isolation, Sensory Deprivation, and Sensory Rearrangement on Visual, Auditory, and Somesthetic Sensation, Perception, and Spatial Orientation

Sidney Weinstein, Ph. D.

Departments of Rehabilitation Medicine & Neurology
Albert Einstein College of Medicine

Table of Contents

Introduction

This report describes the progress achieved on Grant NsG 489, The Effects of Isolation, Sensory Deprivation, and Sensory Rearrangement on Visual, Auditory, and Somesthetic Sensation, Perception, and Spatial Orientation, during the first six months of the third year of the grant (September 1, 1965 - February 28, 1966).

Essentially, the period has been devoted to extension of our sensory deprivation research to new isolation groups, and continuation of the data analysis of the total sensory deprivation experiment completed during the previous year's grant.

The report is presented in four sections:

I. Research Results
II. Equipment and System Development
III. Research Plans
IV. Grant Administration

I. Research Results

Analysis of EEG Frequency Spectrum

We have continued to analyze the EEG data gathered last year in the total sensory deprivation experiment. As described in our earlier progress reports, the analysis comprises the following steps:

1. EEG data are recorded on magnetic tape for 15 minutes of every hour that S is in isolation. Three brain areas are monitored from each S: midline occipital (O), dominant temporal (T) and dominant sensorimotor (SM), each referenced to the vertex (V).

2. Each EEG channel is analyzed by means of the Computer of Average Transients (CAT) operating in the "H" mode. For each 15 min. sample, the analysis yields a distribution of frequency of occurrence of the various regions of the EEG spectrum from 1.0 to 25 cps.

3. The frequencies are then combined to provide four bands: beta (12.5-25 cps), alpha (7.55-12.49 cps), theta (3.51-7.49 cps) and delta (1.00-3.50 cps). The percentage of the total activity represented by each frequency band is then computed.

4. The relative percentages of activity in the four frequency bands are plotted for each S, for each hour he remains in isolation, and for each electrode location.

The analysis has been completed for a total of 7 Ss; data from two additional Ss remain to be analyzed in the total sensory deprivation group. Approximately 900 usable 15 minute samples (i.e., those in which the EEG signal is not obscured by high noise levels) have been analyzed to date.

Visual inspection of the data plots for the 7 Ss indicates that their data fall into three major categories: 2 Ss whose frequency distributions are virtually identical from all three leads; 4 Ss whose distributions are markedly dissimilar from lead to lead, and 1 S whose records can not be clearly classified into either of the above categories. The categorization is, of course, subjective and still preliminary in nature. Figs. 1-8 (presented below) illustrate the similar and dissimilar categories.

A similar EEG pattern from all three areas is illustrated for one S in Figs. 1-4. This individual remained in isolation for the full 72 hours; usable EEG records were available only for the first 19 hours in isolation. It can be inferred from activity shown on all leads that S began the isolation session in a fairly relaxed state, quite possibly light sleep. In the 7th, 8th and 9th hours, he appears to have become quite alert.

FIG. 1 S 9 EEG DURING ISOLATION
PERCENTAGE OF ACTIVITY IN BETA BAND (13-25cps)

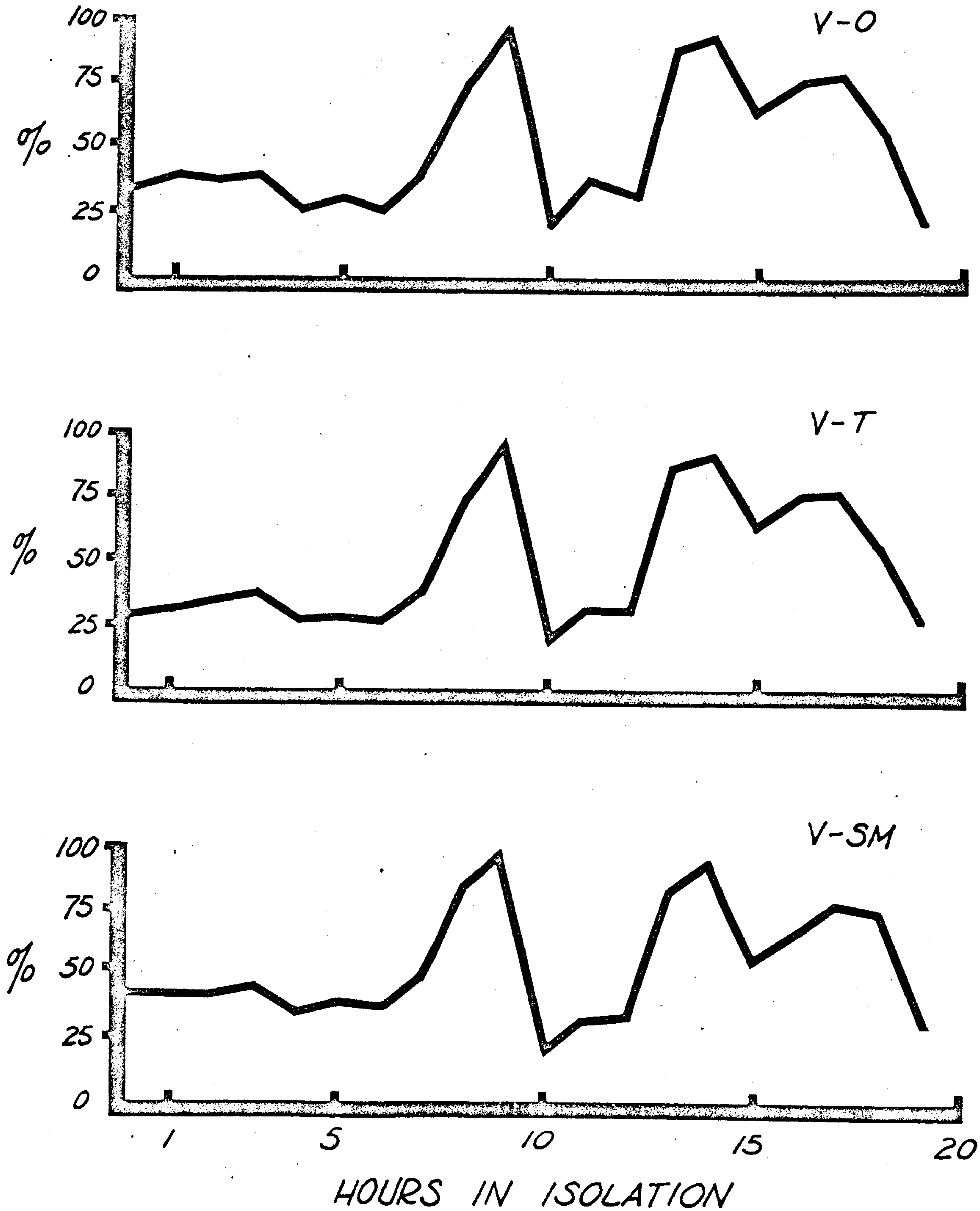
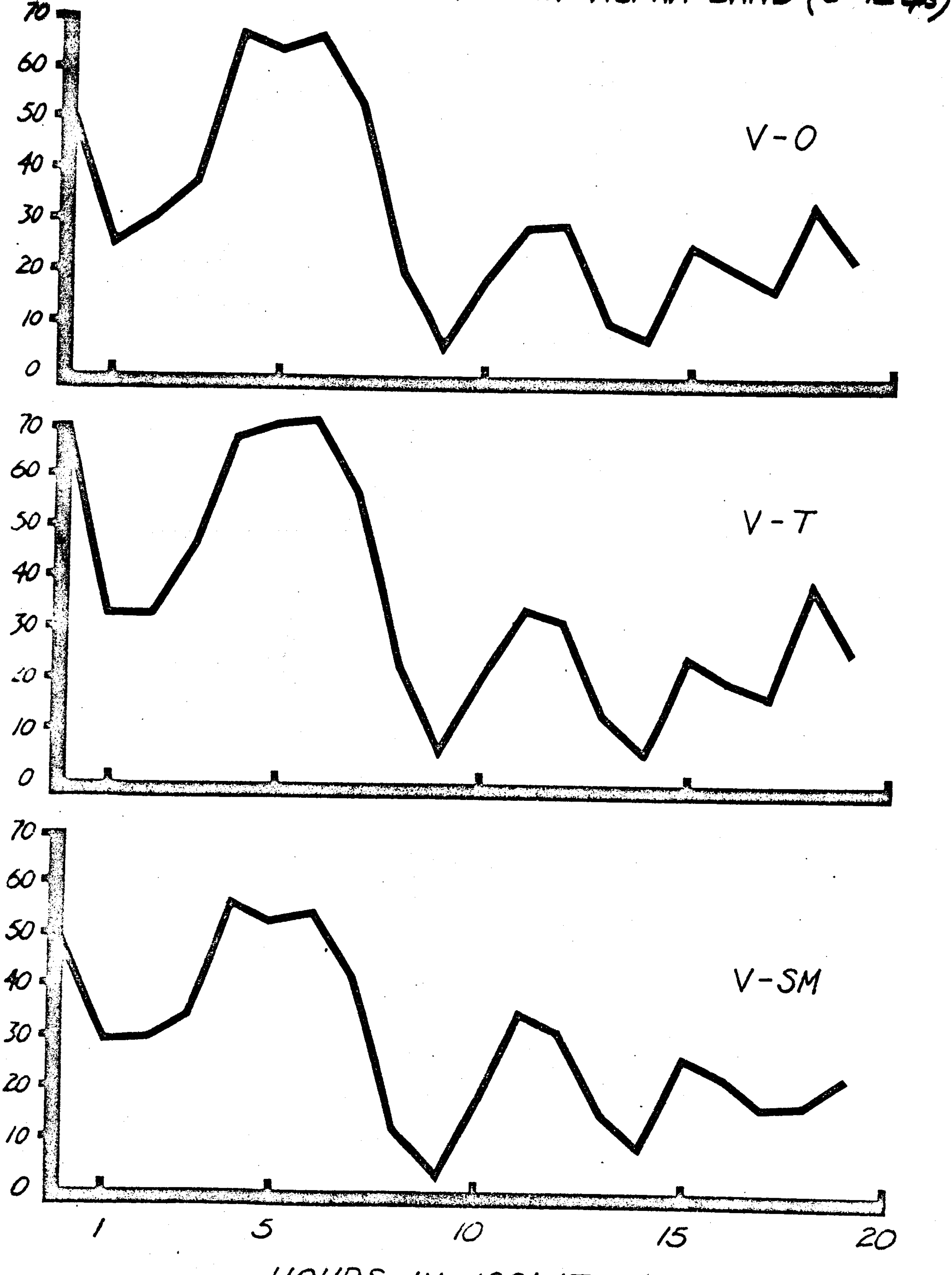


FIG 2 S 9 EEG DURING ISOLATION

PERCENTAGE OF ACTIVITY IN ALPHA BAND (8-12 cps)



~~FIG. 3 S 9 EEG DURING ISOLATION~~

PERCENTAGE OF ACTIVITY IN THETA BAND (4-7cps)

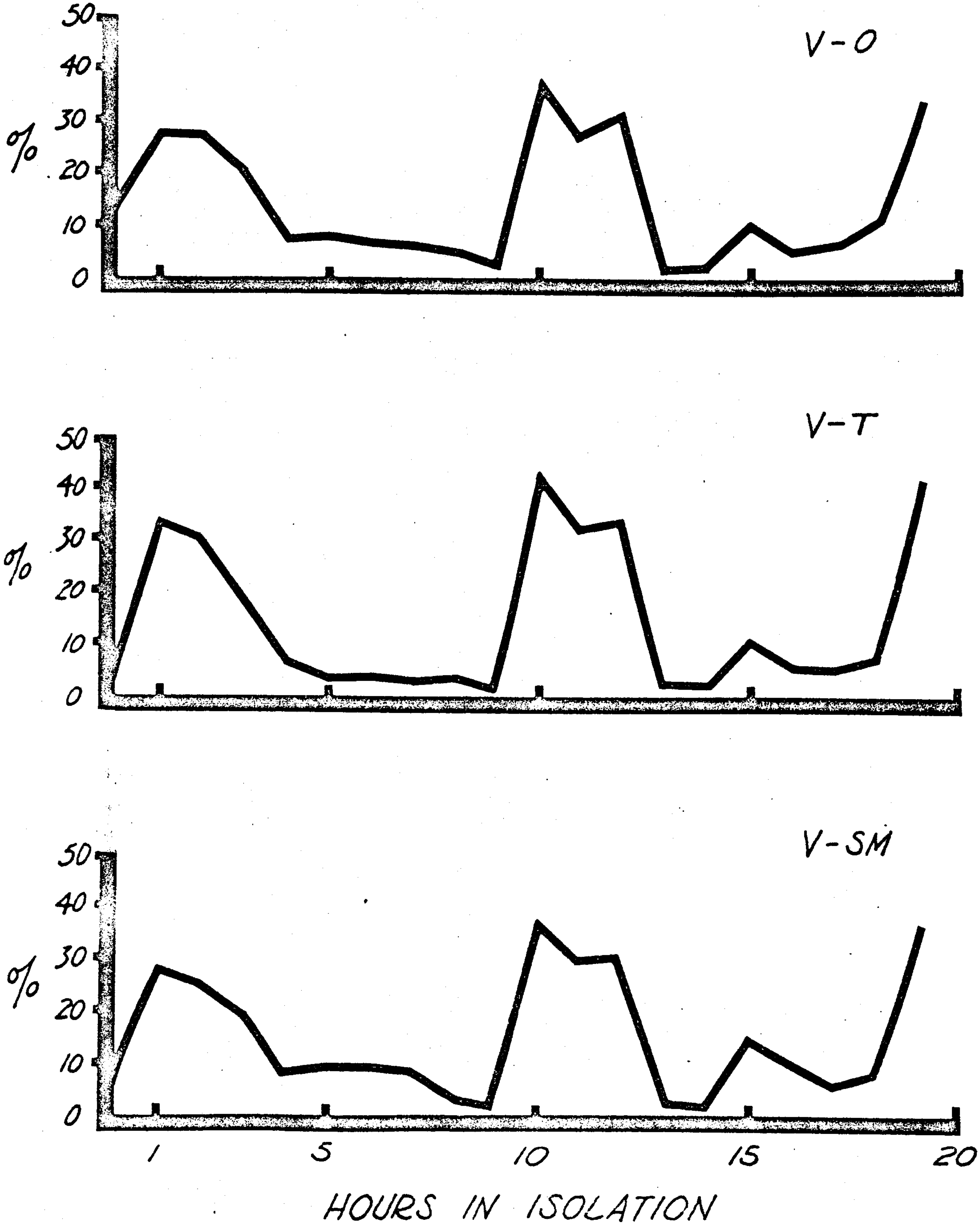
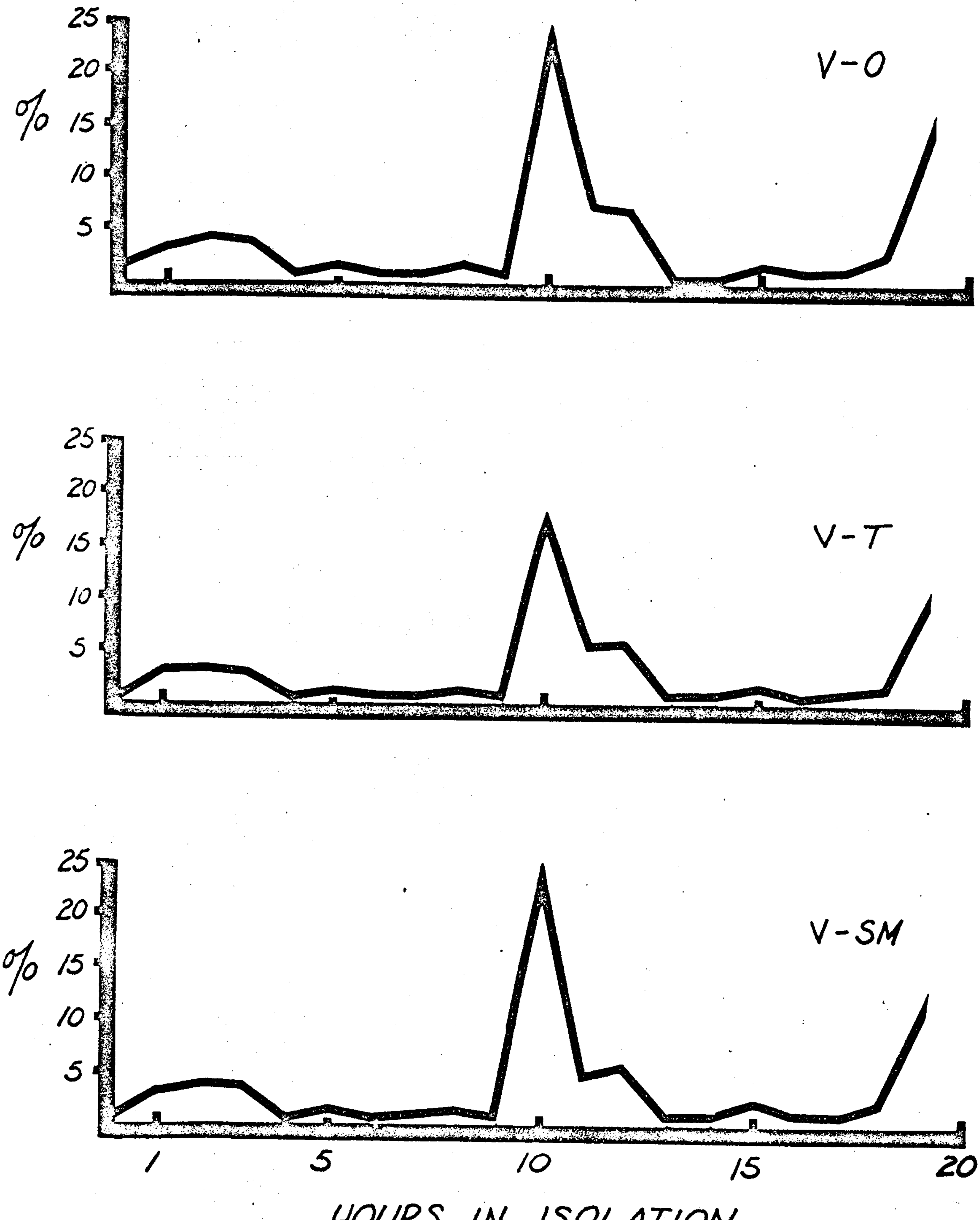


FIG. 4 S 9 EEG DURING ISOLATION

PERCENTAGE OF ACTIVITY IN DELTA BAND (1-3.9cps)



The peaked theta and delta activity indicate that he then fell into a deep sleep for 2-3 hours. S was alert and awake for approximately the next 4 hours, and seemed to be back in deep sleep in the final available records. It might be noted that the observational records maintained by the monitors during S's isolation conform quite well to the above description (except for hours 13, 14 and 15 when S seemed to the monitors to be asleep).

Figs. 5-8 present the EEG records for S 17, who showed dissimilar EEG patterns from the three areas. These records are representative of the three other Ss who also showed different distributions from the three EEG leads. S 17 remained in isolation for only 31.5 hours, during which time his EEG records were complete. In general, the high percentage of fast, beta activity indicates an aroused, alert individual. The fast activity appears generally on all three leads in the beginning of isolation. It then increased continuously from the temporal lead, and remained fairly substantial from the occipital and sensorimotor leads. All three leads show rising beta activity during the last hour prior to S's request for release from isolation. This probably indicates increasing arousal at this point. In confirmation of this point, theta and delta activity were quite low at the end of isolation, and alpha activity decreased in all three channels. The lowered occurrence of alpha in the thirty-first hour can be observed in the sensorimotor area, which showed fairly constant alpha activity throughout isolation, in the occipital area, which had shown a substantial and rising alpha, and in the temporal area, in which alpha had been fairly low and was decreasing during isolation. Thus, this S shows a pattern of generally high arousal level early in isolation, some evidence for continued or increased arousal during isolation, and clear evidence of an increasing level of arousal just prior to voluntary termination of isolation. A clear-cut interpretation of the data from the remaining Ss with dissimilar patterns was not immediately apparent.

It is evident that many complex analyses of the EEG data can be performed in addition to those presented above. For example, some Ss show highly variable records from hour to hour, while others present a smooth, linear function. Additionally, there may be correlations between activity in the

FIG. 5 S 11 EEG DURING ISOLATION

PERCENTAGE OF ACTIVITY IN BETA BAND (13-25 cps)

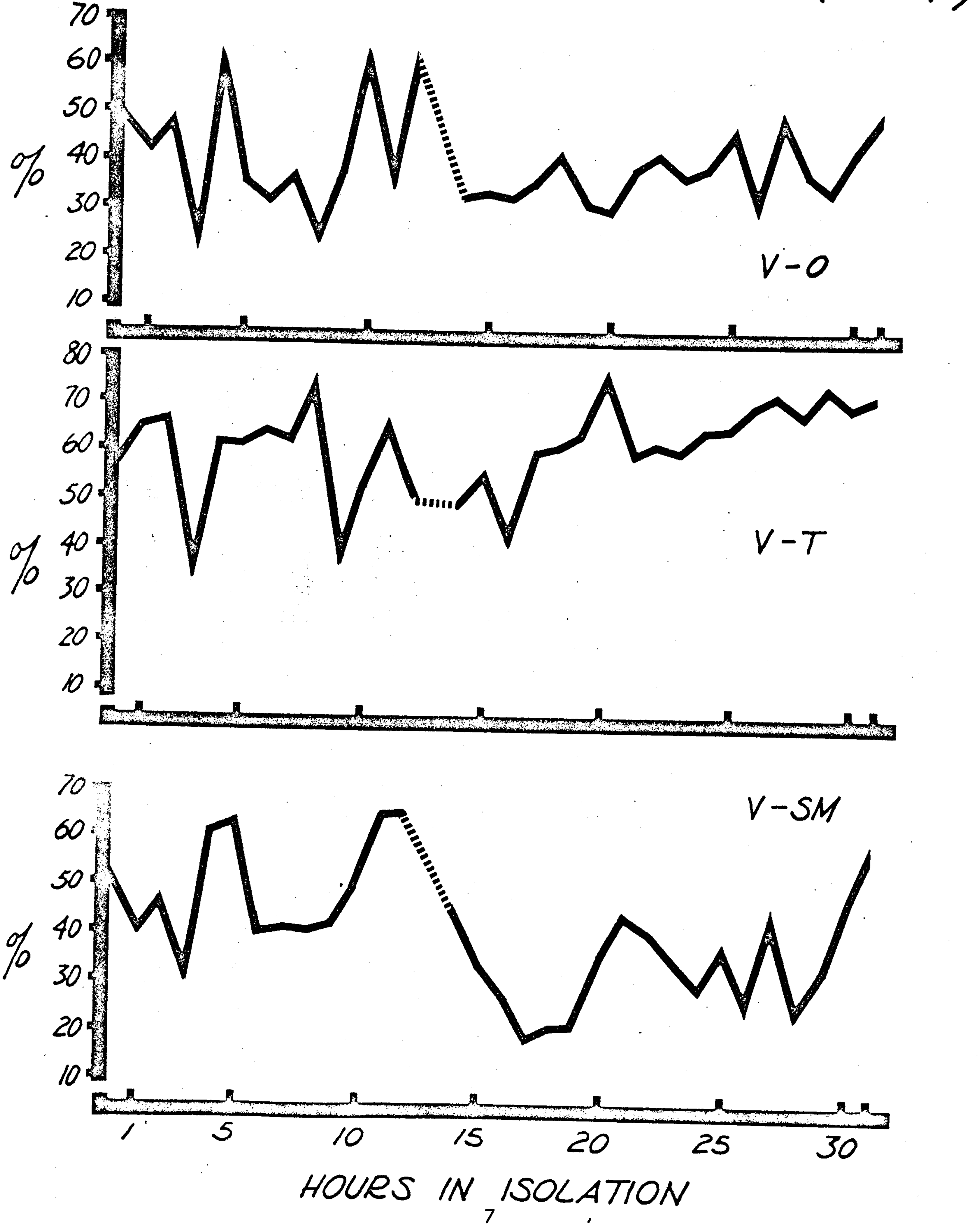


FIG. 6 S 17 EEG DURING ISOLATION

PERCENTAGE OF ACTIVITY IN ALPHA BAND (8-12 cps)

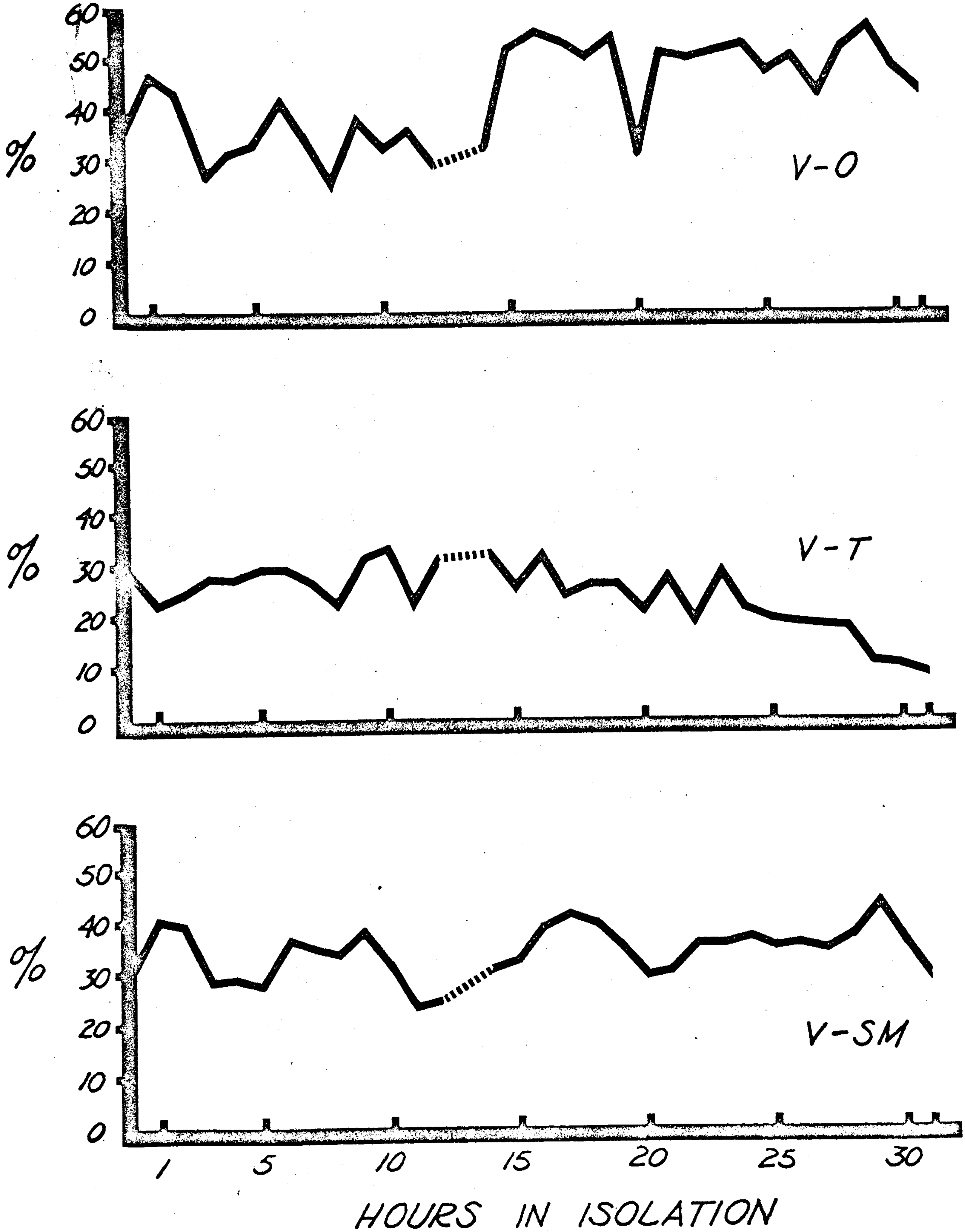


FIG. 7 S 17 EEG DURING ISOLATION

PERCENTAGE OF ACTIVITY IN THETA BAND (4-7cps)

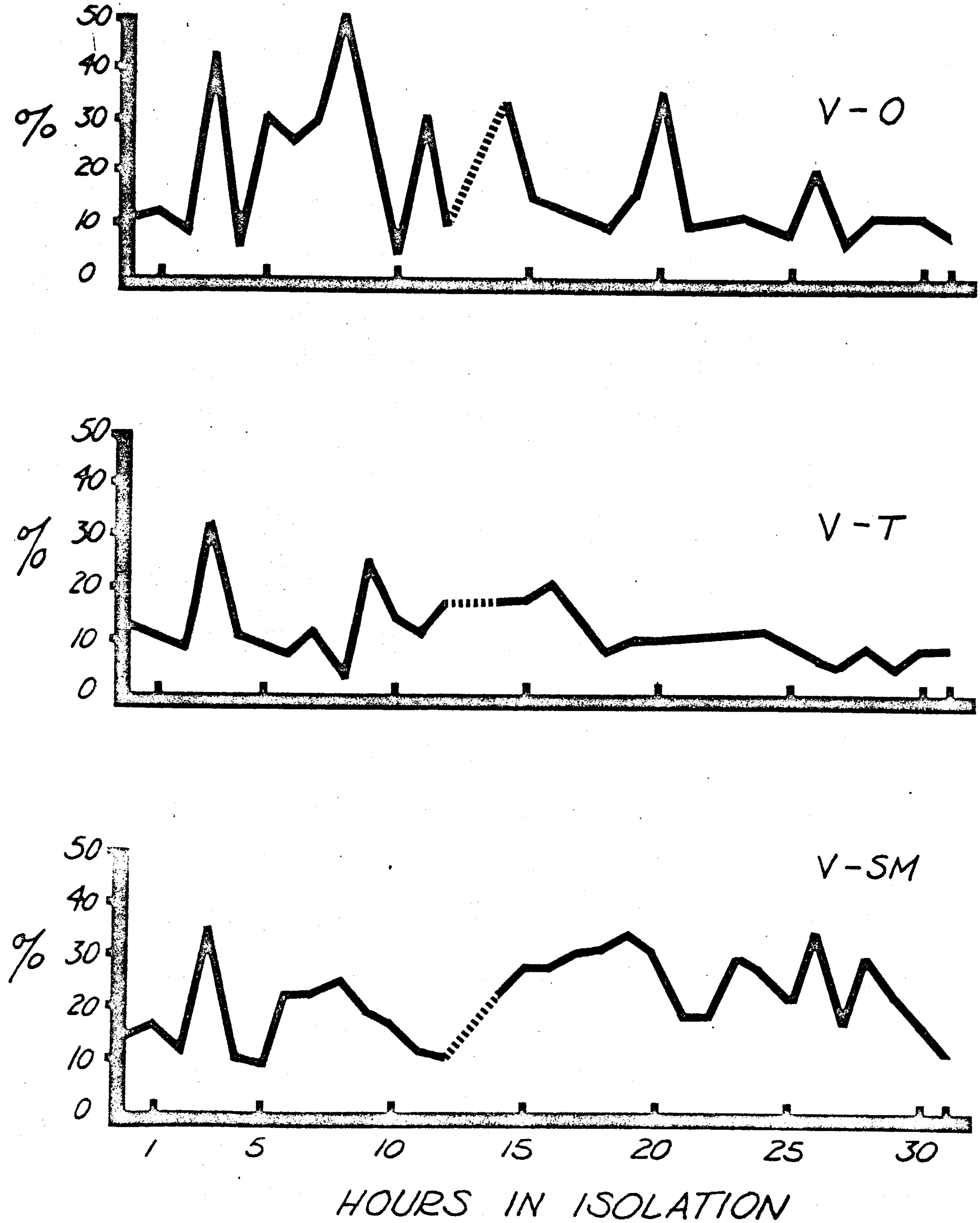
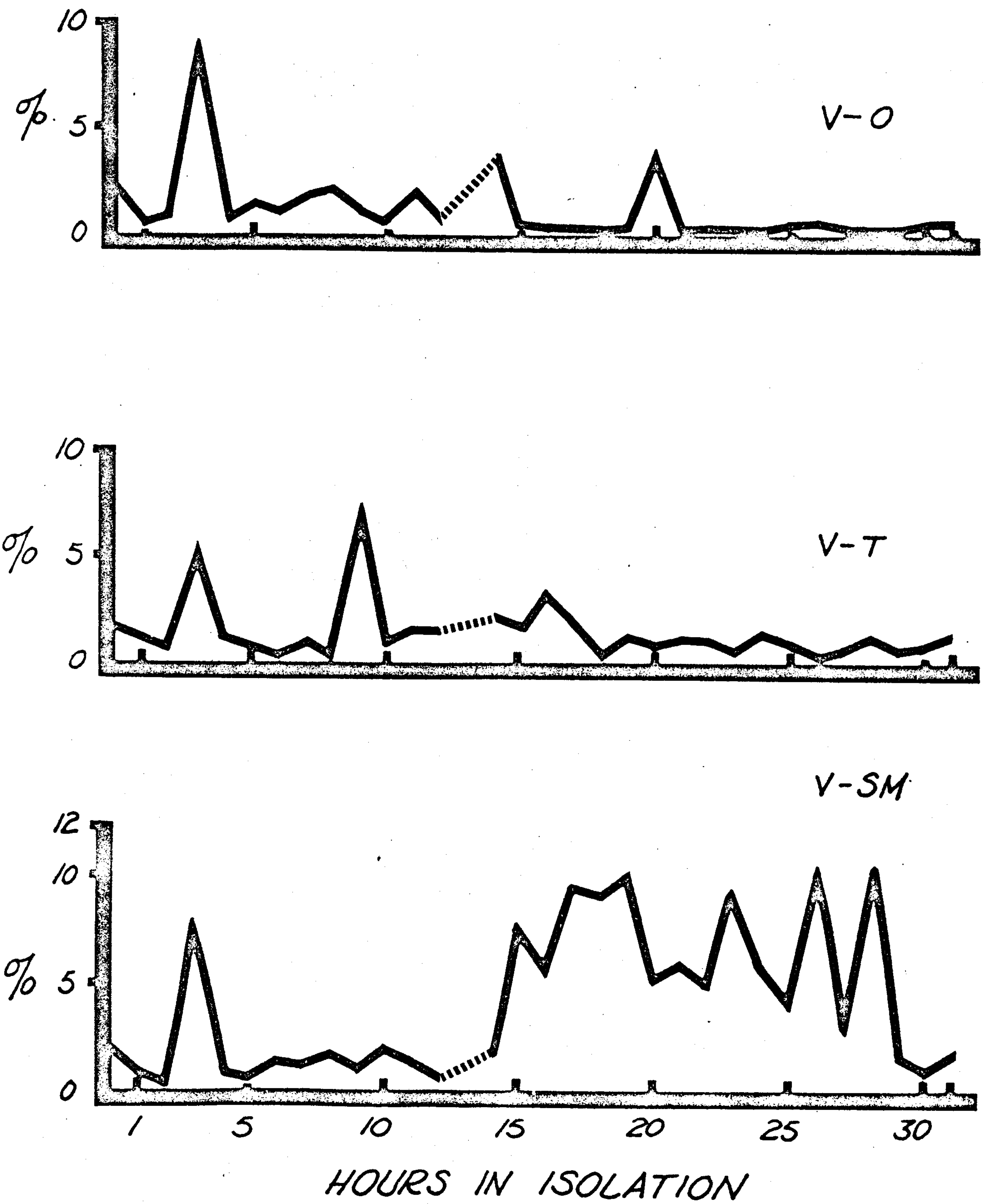


FIG. 8 S17 EEG DURING ISOLATION
PERCENTAGE OF ACTIVITY IN DELTA BAND (1–3.9 cps)



various bands and such variables as number of hours in isolation (as we have shown in an earlier report), circadian rhythms, voluntary termination of isolation, etc. These analyses will be undertaken when the frequency spectrum analysis has been completed for the nine sensory deprivation Ss.

In Fig. 9, we present preliminary data showing increasing proportion of beta activity in the occipital area as a function of time in isolation. The plot is based on five Ss who appeared to show this change. Unfortunately, the N was reduced at subsequent time points, so that after 25 hours there were only two Ss with data. Nevertheless, the data demonstrate a rising percentage of beta activity, an indication of increased arousal with time in isolation. A similar trend of increasing arousal based upon basal skin resistance data has also been reported earlier by us.

It is expected that upon completion of the EEG frequency spectrum analysis for all available sensory deprivation Ss, we will be able to perform group analysis (e.g., correlations with time in isolation) as well as future comparisons with different isolation groups.

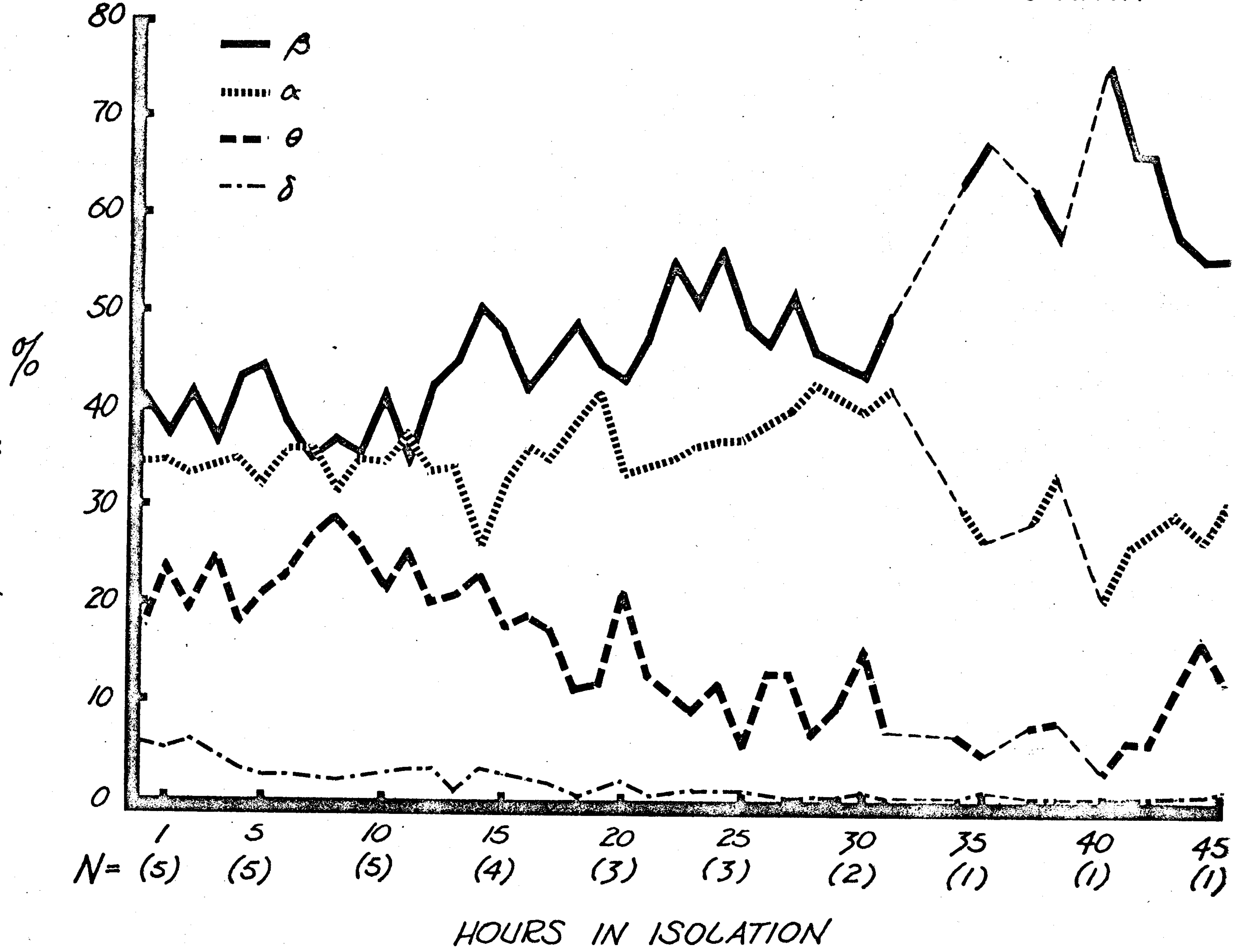
New Experimental Groups

Social, auditory, and movement deprivation. Our first experiment, total sensory deprivation, was completed at the end of the last grant year. The second experimental condition employed the same basic procedures, except there was no visual or tactual deprivation. That is, this group was tested with the same pre- and postisolation test battery as the total isolation group, was placed in the isolation chambers for a scheduled 72 hours, and ate the same foods, etc. as the total sensory deprivation group. However, vision was not occluded nor were the tactual isolating devices applied.

The Ss did wear auditory occluders and were instructed to move as little as possible*. Before S entered the isolation chamber he was supplied with reading material (paper-back books and current magazines) which

* This group, as well as the group with only vision available (described below) are considered to be equivalent to the total sensory deprivation group for motor deprivation. Actually, they moved and sat up more frequently since they were permitted to read.

FIG. 9 MEAN PERCENT EEG ACTIVITY DURING ISOLATION



he was allowed to read at will. The cubicle lights remained on continuously, and Ss were provided with light shields for their eyes to use when they desired to sleep. The results of this experiment will be described below.

Social, tactual, auditory, and movement deprivation. This experimental group was identical to the one described above, except that Ss wore on the preferred and nonpreferred hands the same isolating devices used in the total sensory deprivation experiment. Since vision was not occluded, they were again provided with books, magazines and the light shields.

In both of the new experimental groups the Ss were selected using the same criteria utilized in the first experiment. That is, 1. male, aged 18-40, 2. high school education at minimum, 3. good health (physical and mental) and 4. willingness to serve as a control S or as a 72-hour experimental S in total sensory deprivation.

Results. In the group with visual and tactual stimulation available, 39 Ss were tested, of whom 26 (67%), remained for the full 72-hour period. A total of 20 Ss were placed in isolation with only vision available. Thirteen (65%) remained for the scheduled 72 hours.

At the present time, only a preliminary analysis of the effects of isolation has been completed. In the figures which follow, we present the mean differences between pre- and postisolation for each of the tests in the battery for the two isolation groups. Each group is further subdivided into Ss who remained in isolation for the scheduled 72 hours and Ss who requested early release from isolation.

The group which was not deprived tactually or visually is designated SAM/TV*; the group which was not visually deprived is designated STAM/V*.

Since tests of statistical significance have not been completed, it would not be useful to make detailed comparisons between groups or conditions. However, an overall subjective evaluation of the data indicates no tendency toward consistent decrement or improvement for either of the isolation groups. Consequently, each test will be considered individually when the final statistical analyses are completed.

---

*The symbols are interpreted as follows: the letters refer to the system or modality (S=social, T=tactual, A=auditory, M=movement, V=visual); symbols above the line represent deprived modalities; symbols below the line represent nondeprived modalities.

FIG. 10. HAND TEMPERATURE.

Mean Post- Minus Preisolation Differences. Nonpreferred Hand.

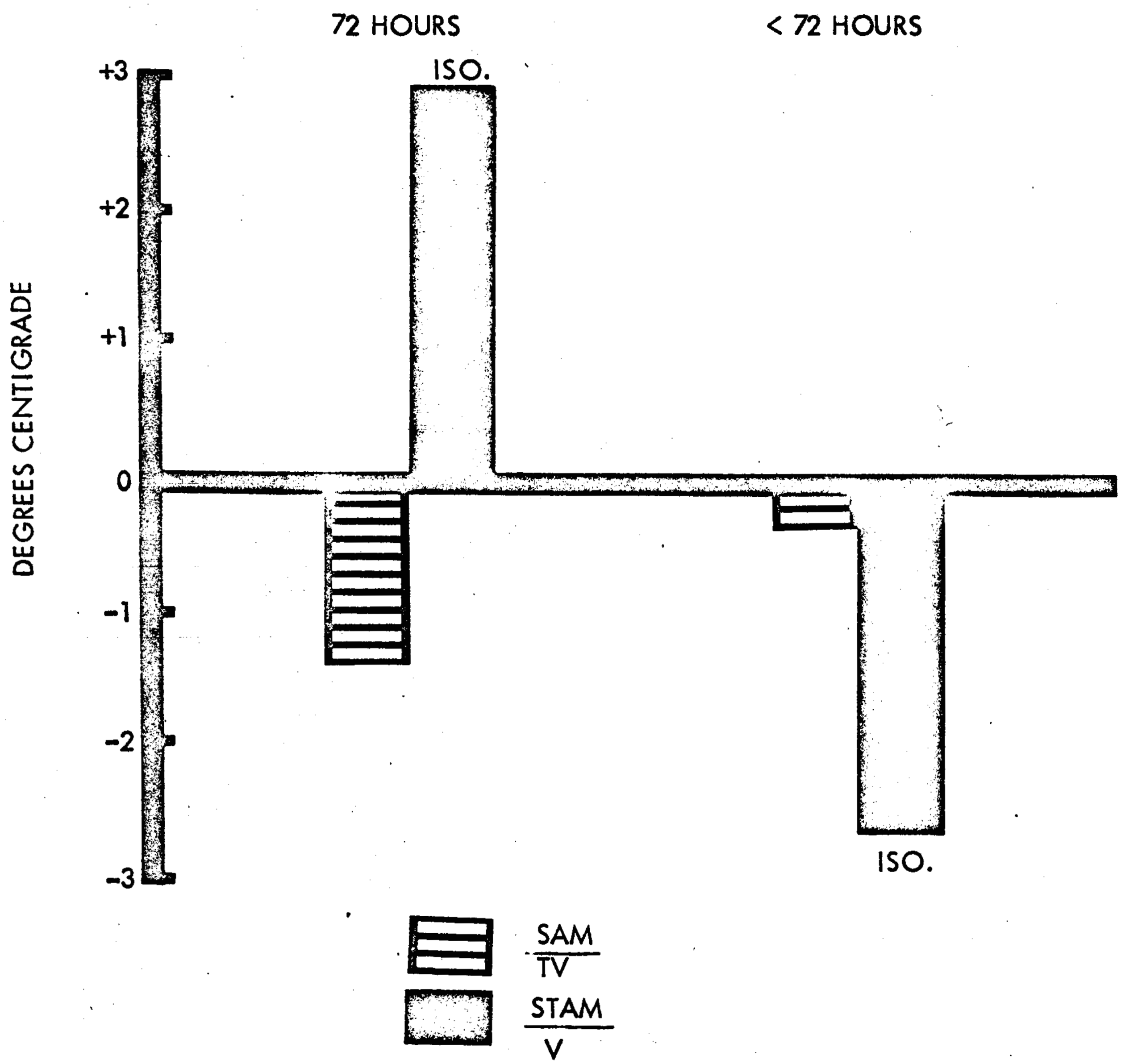


FIG. 11. BODY WEIGHT.

Mean Post- Minus Preisolation Differences.

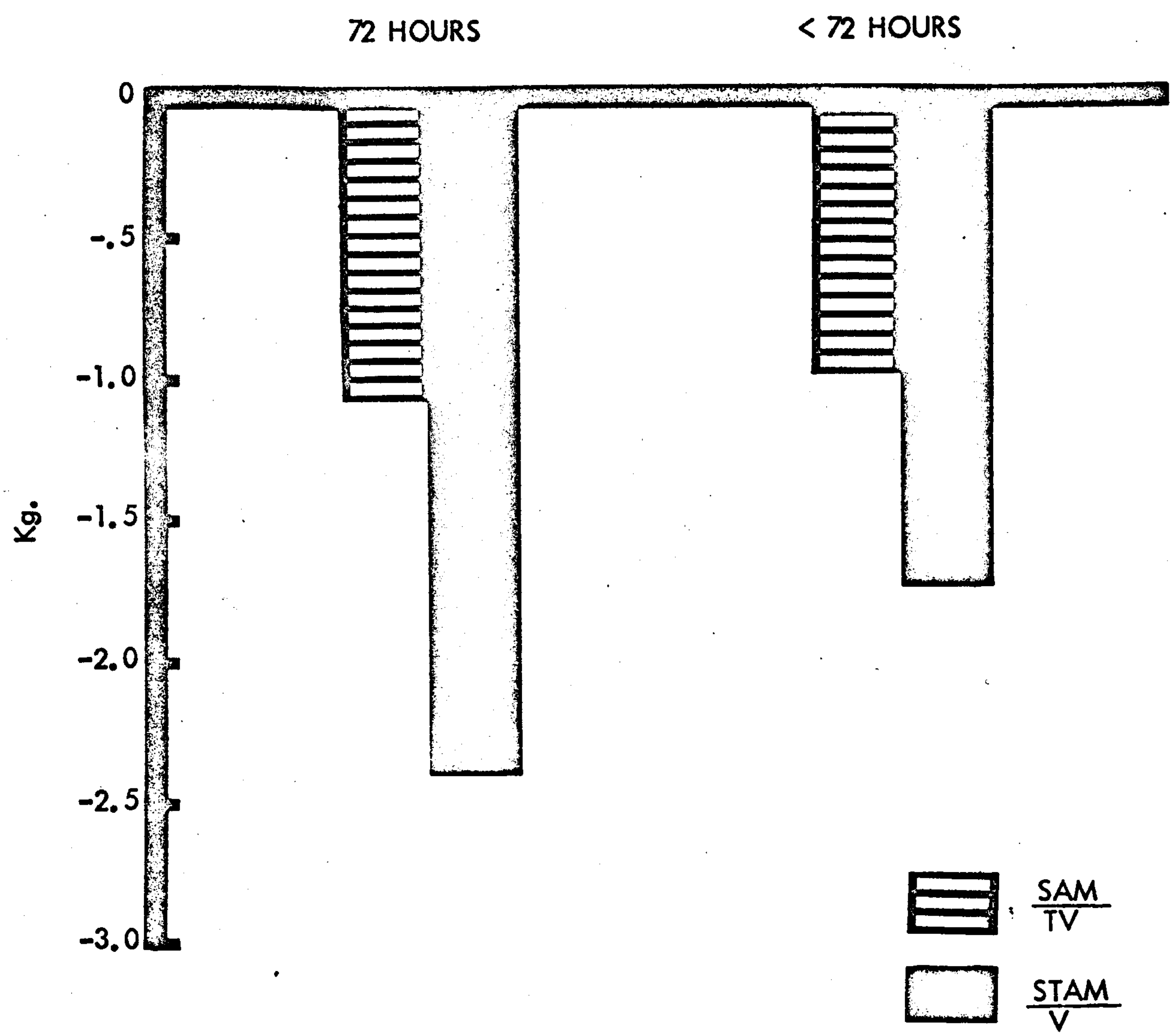


FIG. 12. EAS VERBAL COMPREHENSION.

Mean Post- Minus Preisolation Differences.

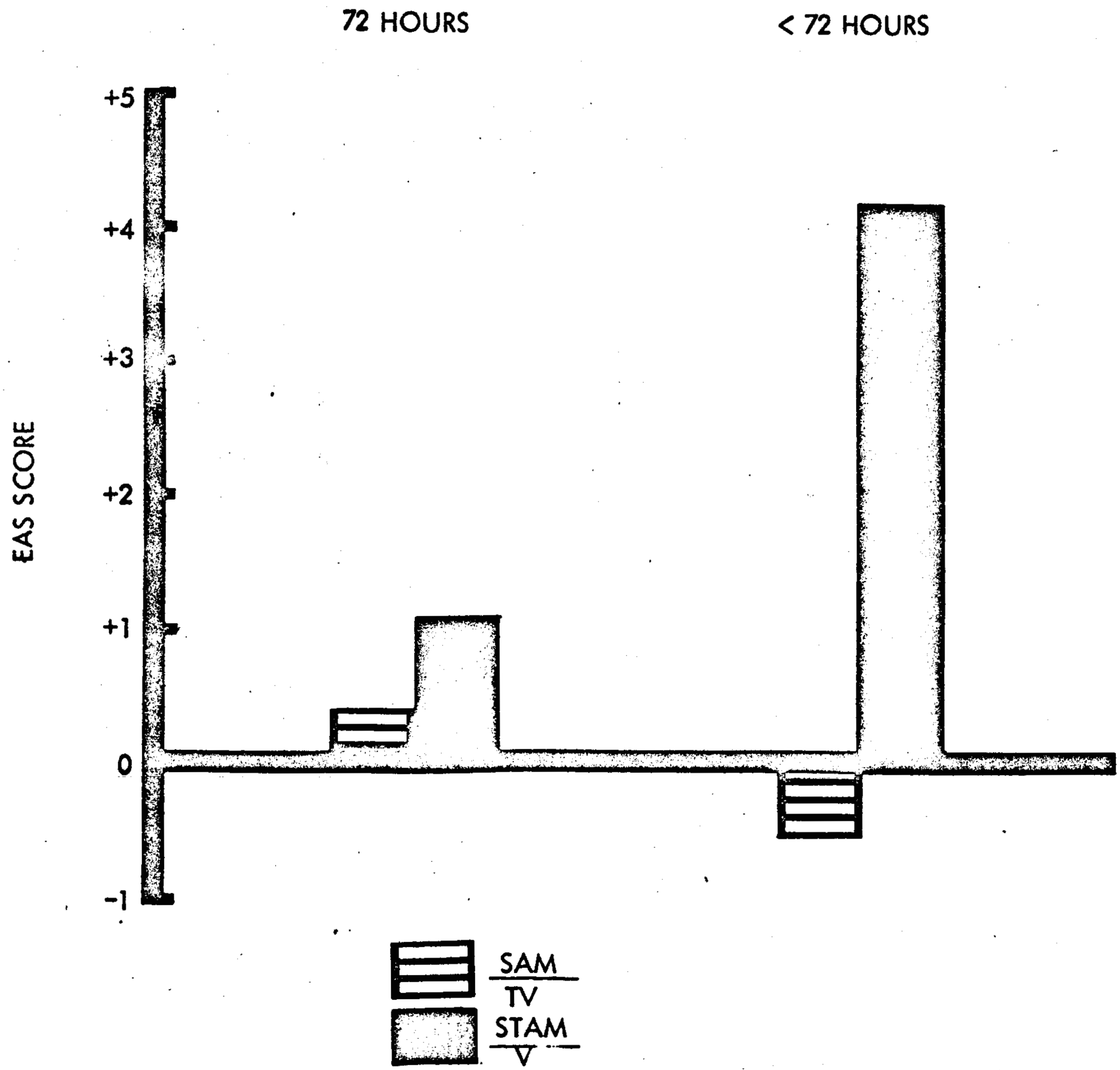


FIG. 13. EAS VISUAL PURSUIT.

Mean Post-Minus Preisolation Differences.

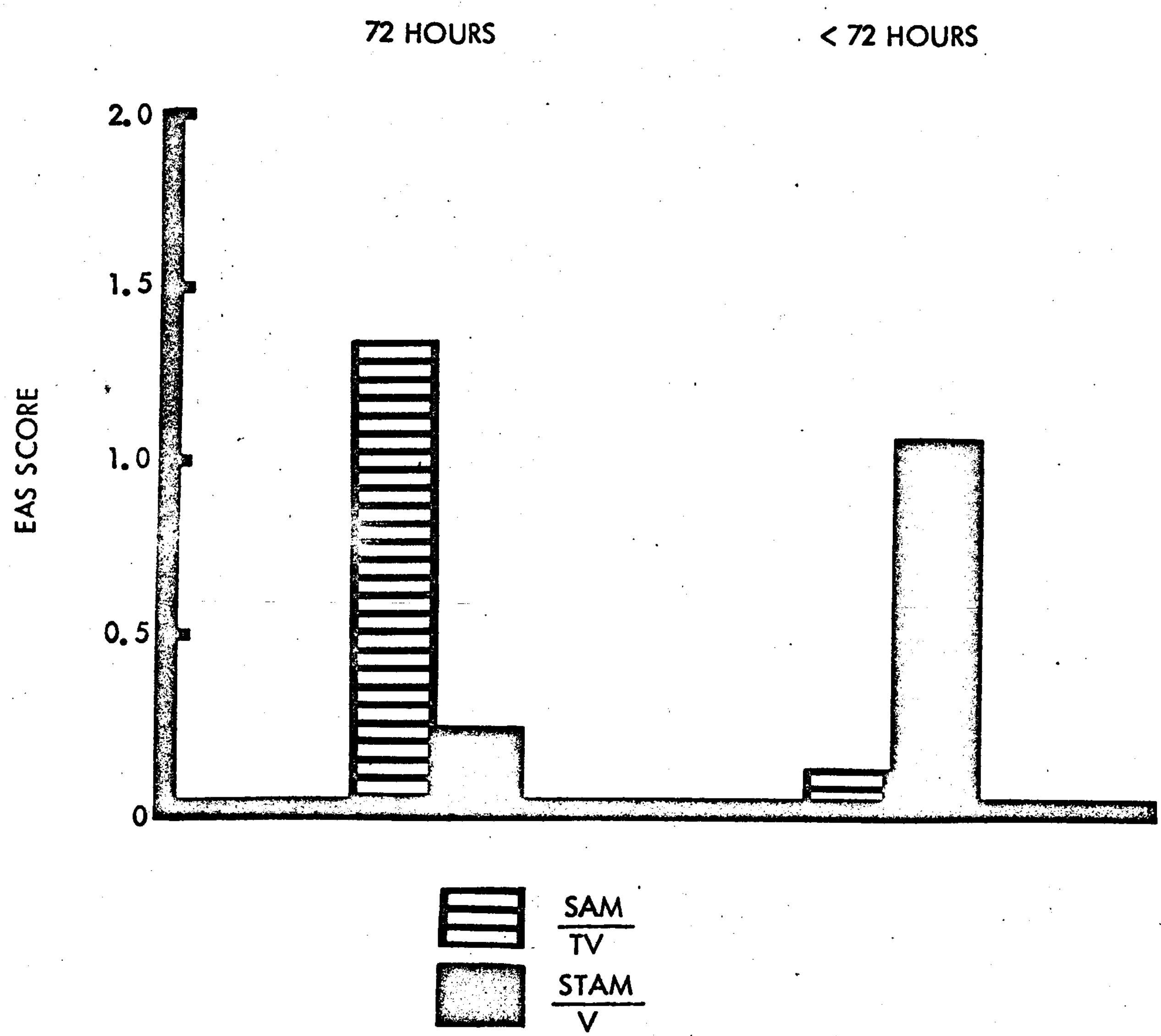


FIG. 14. EAS SPACE VISUALIZATION.

Mean Post- Minus Preisolation Differences.

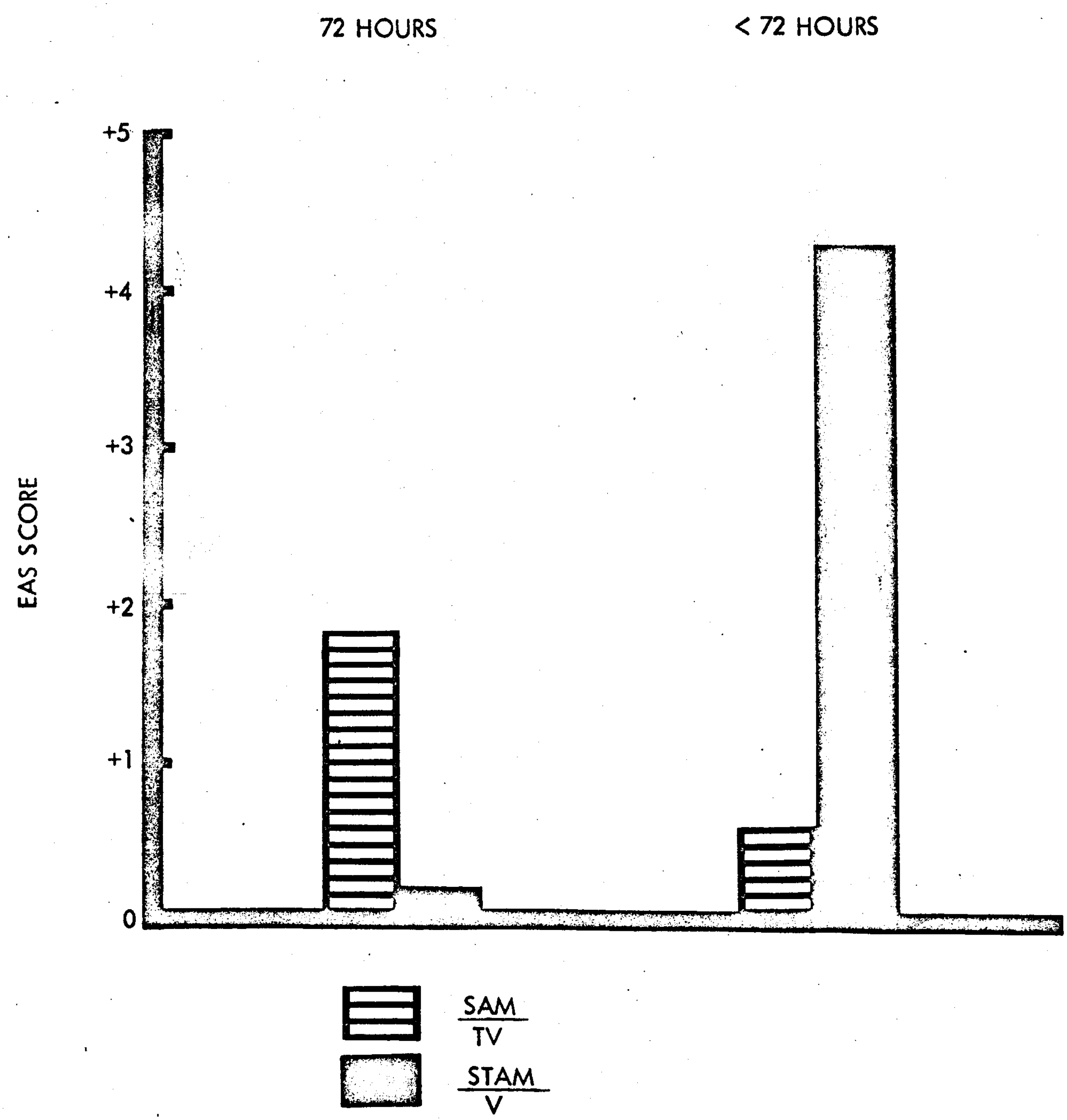


FIG. 15. TIME ESTIMATION.

Mean Post- Minus Preisolation Differences.

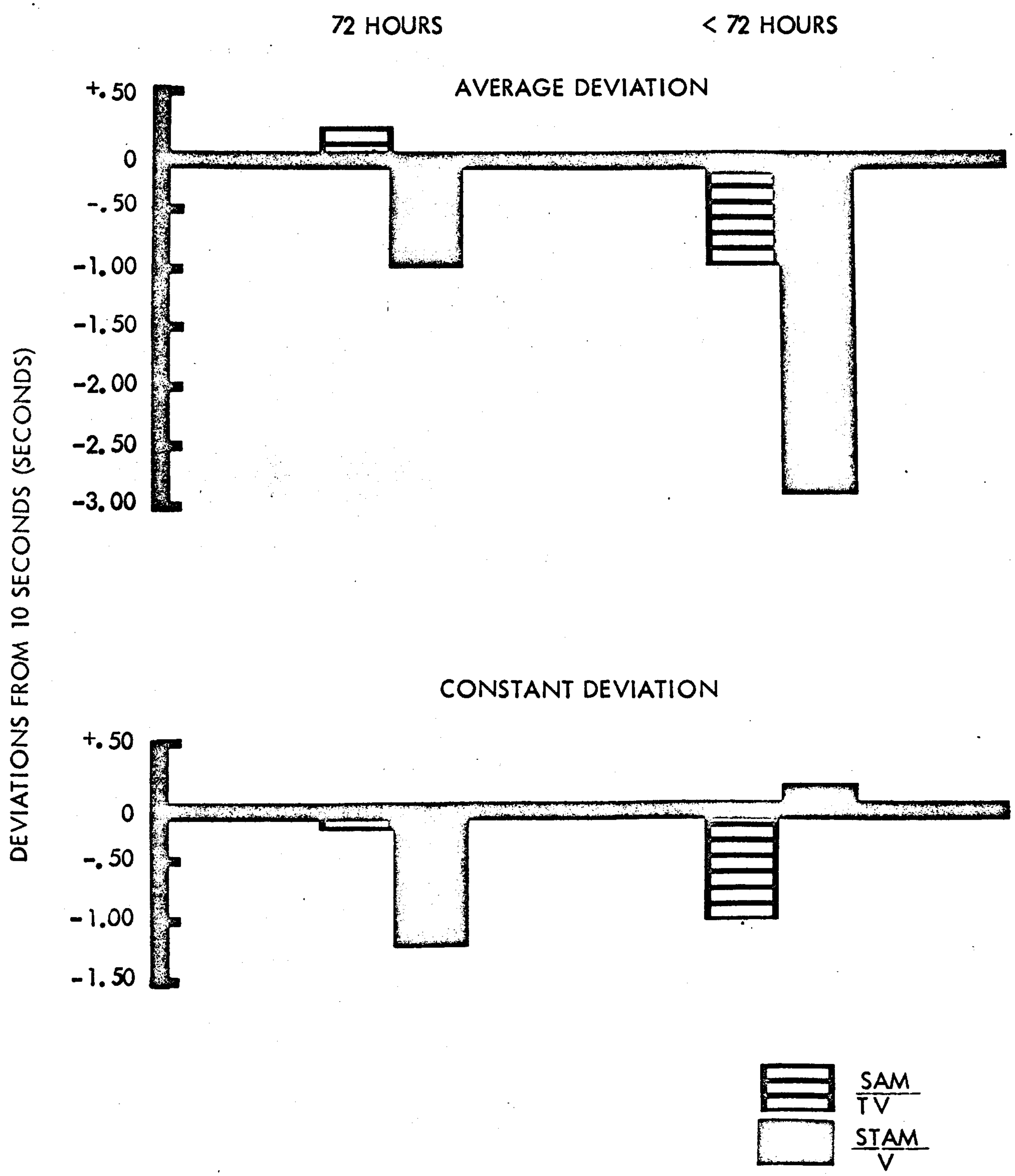


FIG. 16. HAND STRENGTH.

Mean Post- Minus Preisolation Differences.

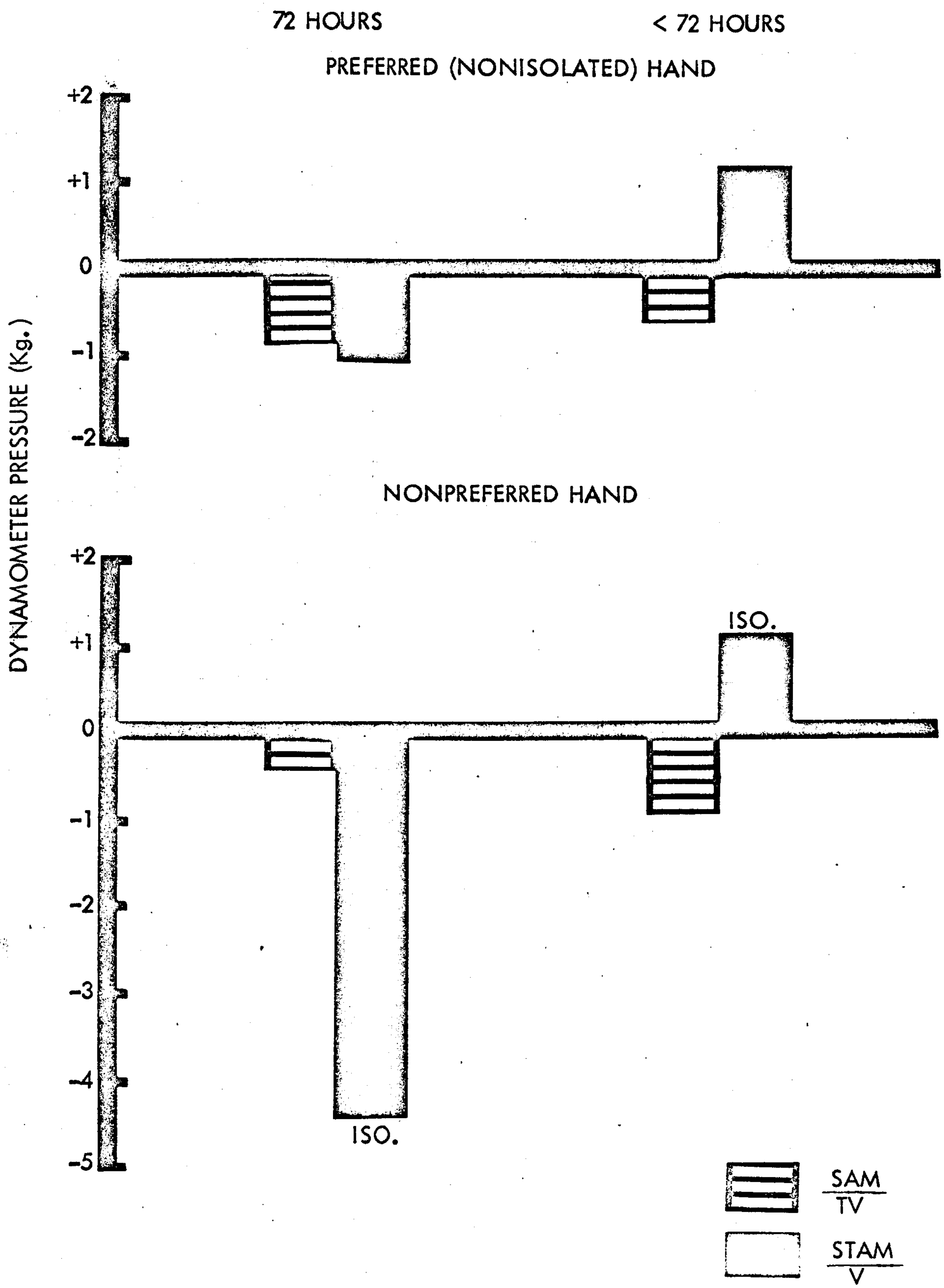


FIG. 17. SPEED OF FINGER OSCILLATION.

Mean Post- Minus Preisolation Differences.

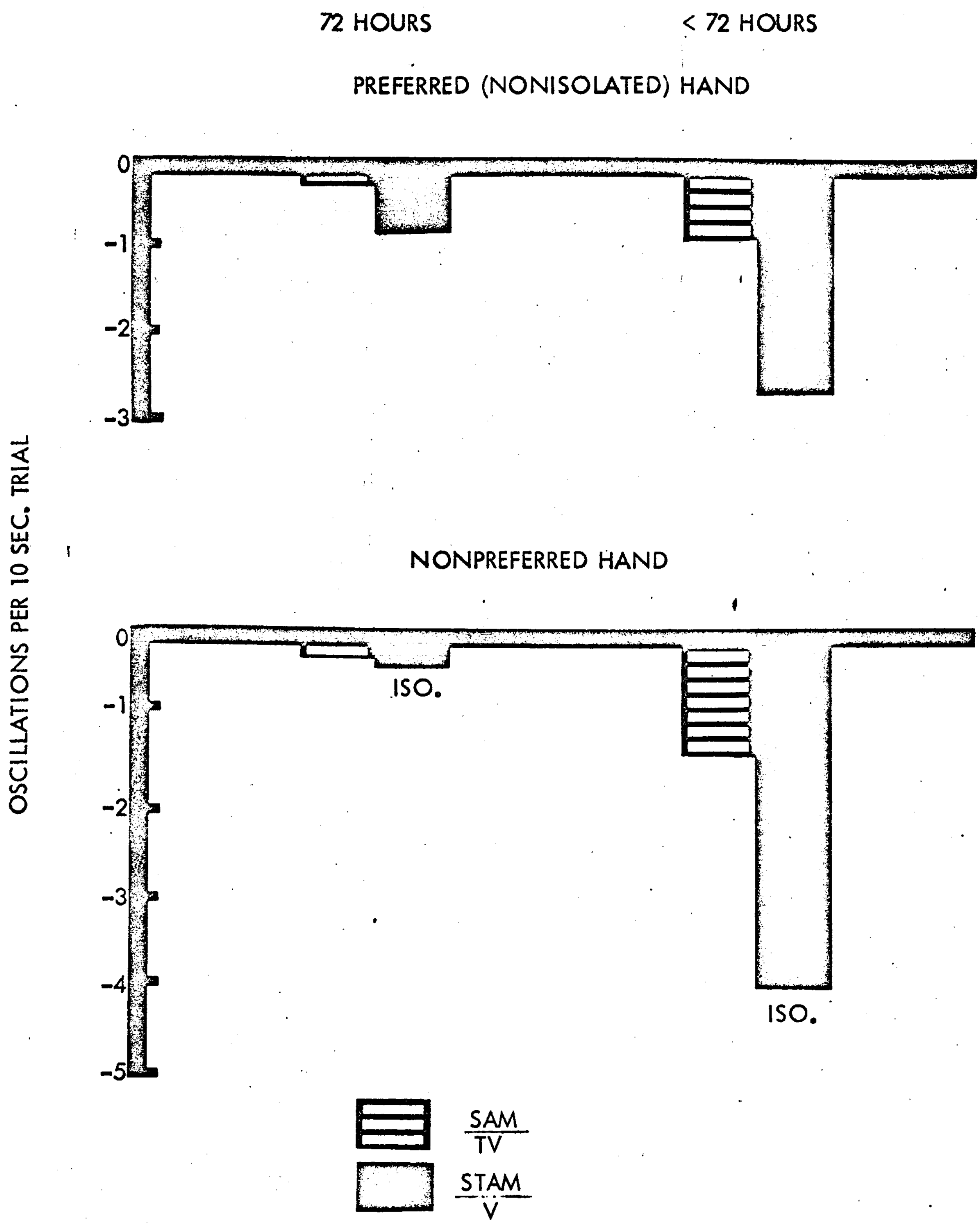


FIG. 18. ABSOLUTE THRESHOLD FOR PRESSURE SENSITIVITY (RL).

Mean Post- Minus Preisolation Differences. Nonpreferred Hand.

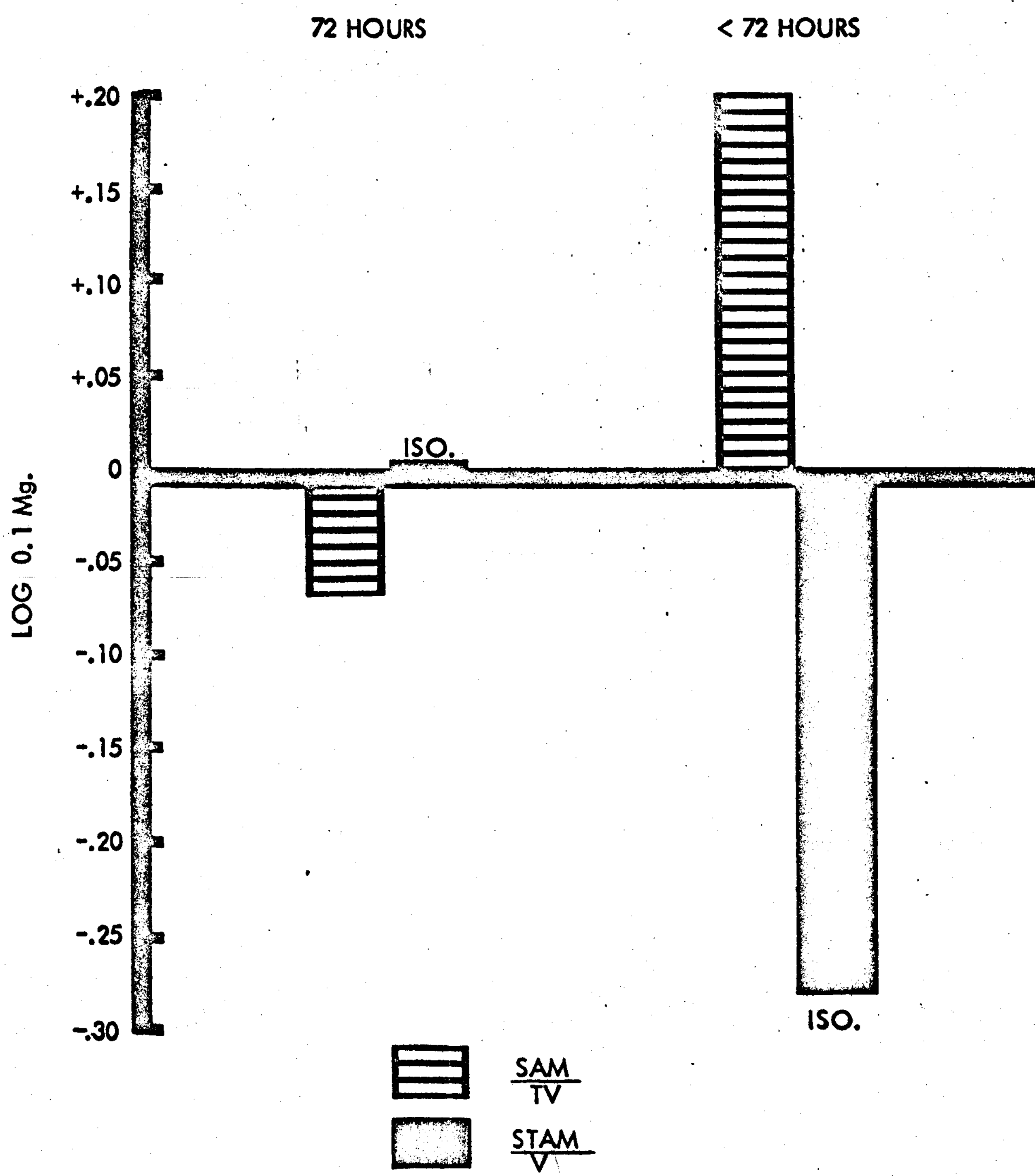


FIG. 19. DIFFERENCE THRESHOLD FOR PRESSURE SENSITIVITY (DL)

Mean Post- Minus Preisolation Differences. Nonpreferred Hand.

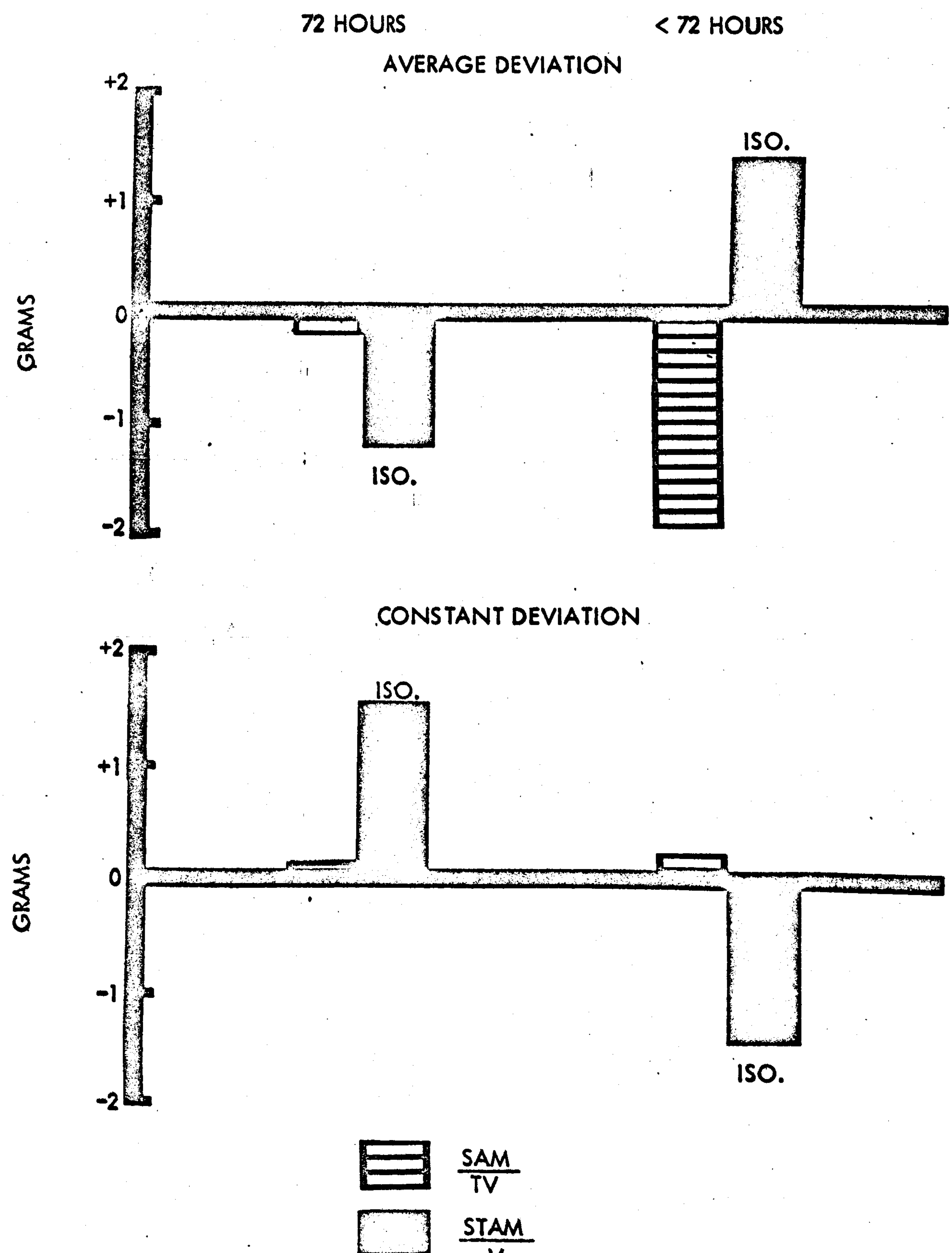


FIG. 20. ABSOLUTE THRESHOLD FOR LOUDNESS (RL).

Mean Post- Minus Preisolation Differences.

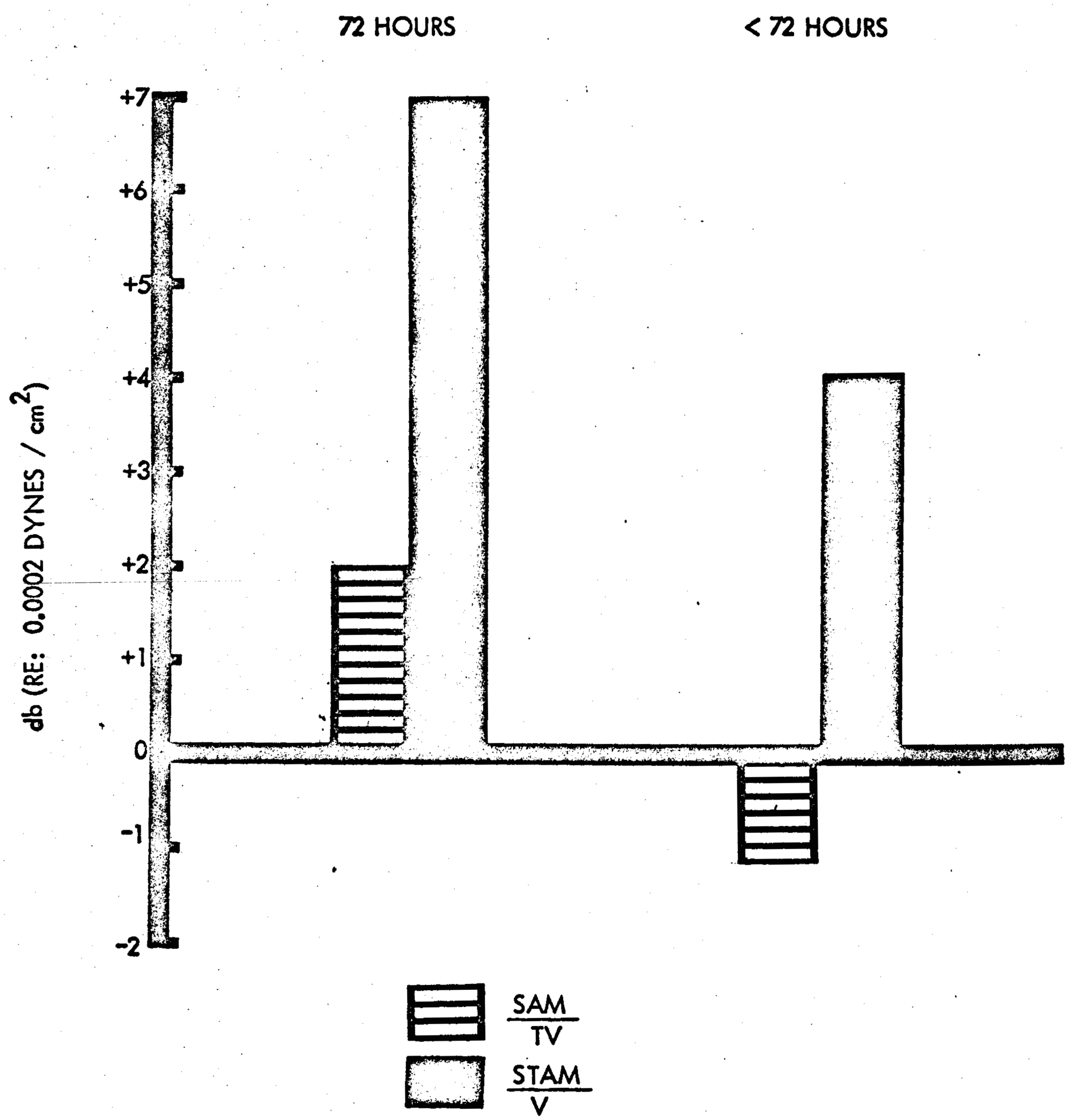


FIG. 21. DIFFERENCE THRESHOLD FOR LOUDNESS (DL).

Mean Post- Minus Preisolation Differences.

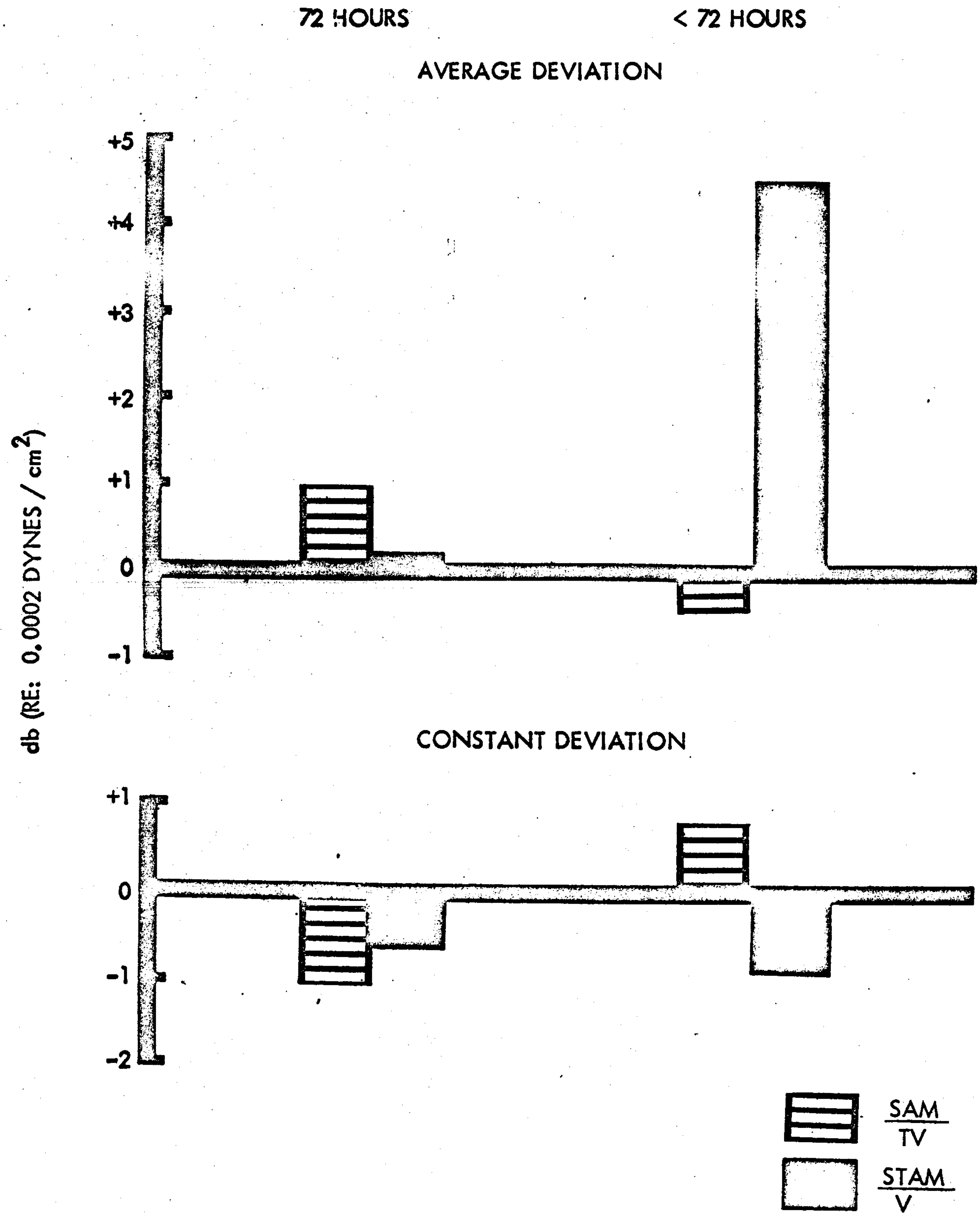


FIG. 22. ABSOLUTE THRESHOLD FOR BRIGHTNESS SENSITIVITY (RL).

Mean Post- Minus Preisolation Differences.

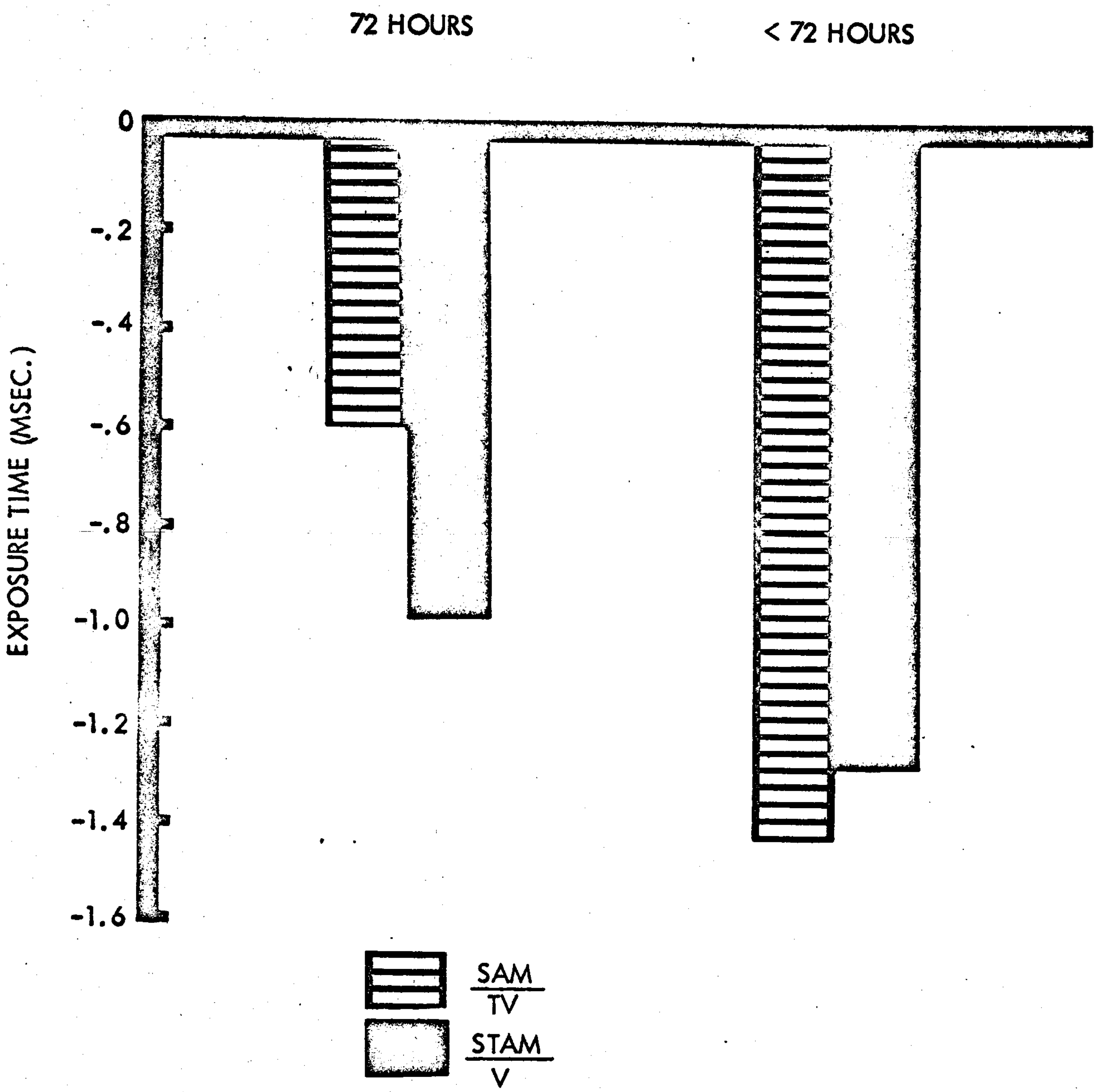


FIG. 23. DIFFERENCE THRESHOLD FOR BRIGHTNESS (DL).

Mean Post- Minus Preisolation Differences.

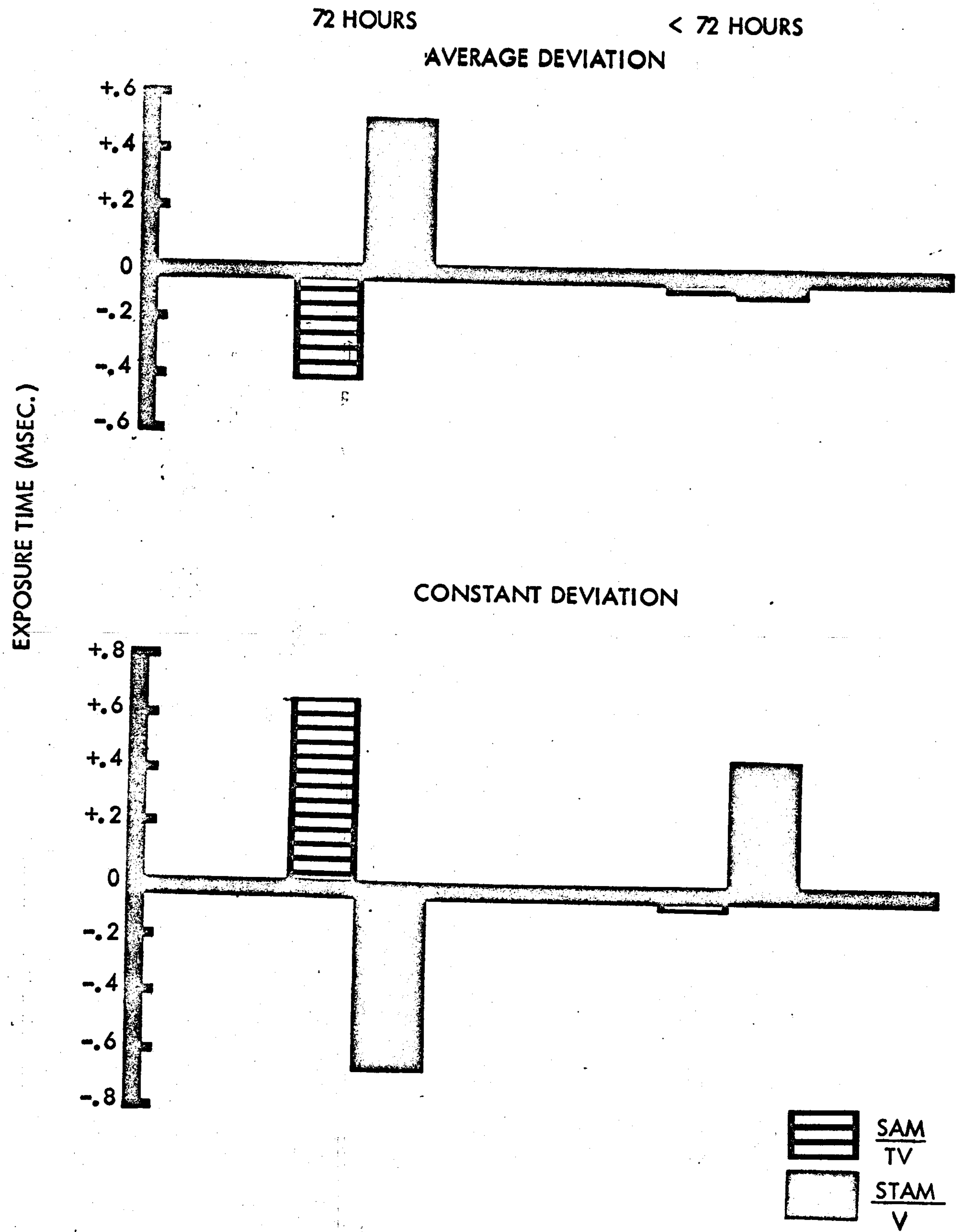


FIG. 24. PAIN THRESHOLD.

Mean Post- Minus Preisolation Differences.

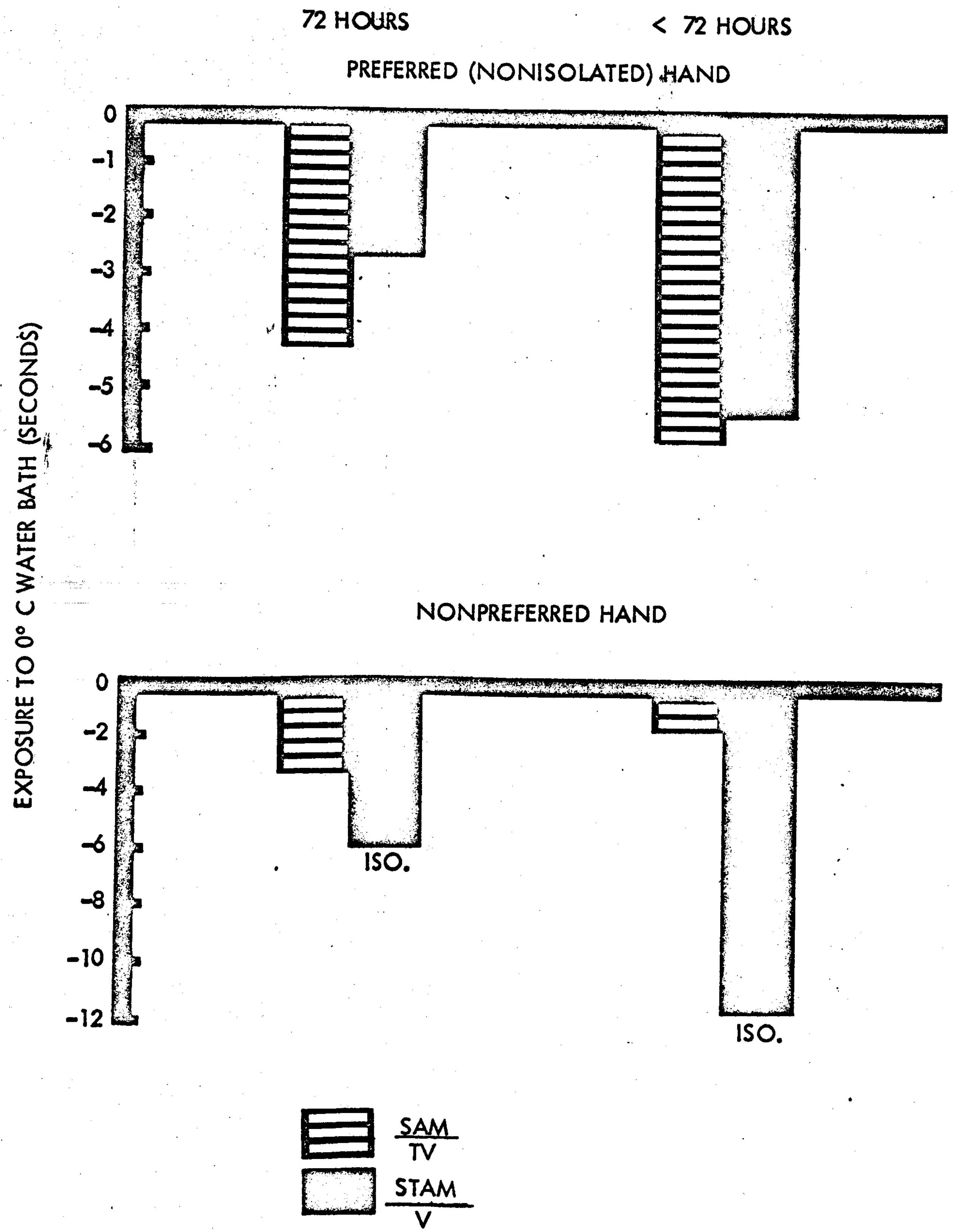
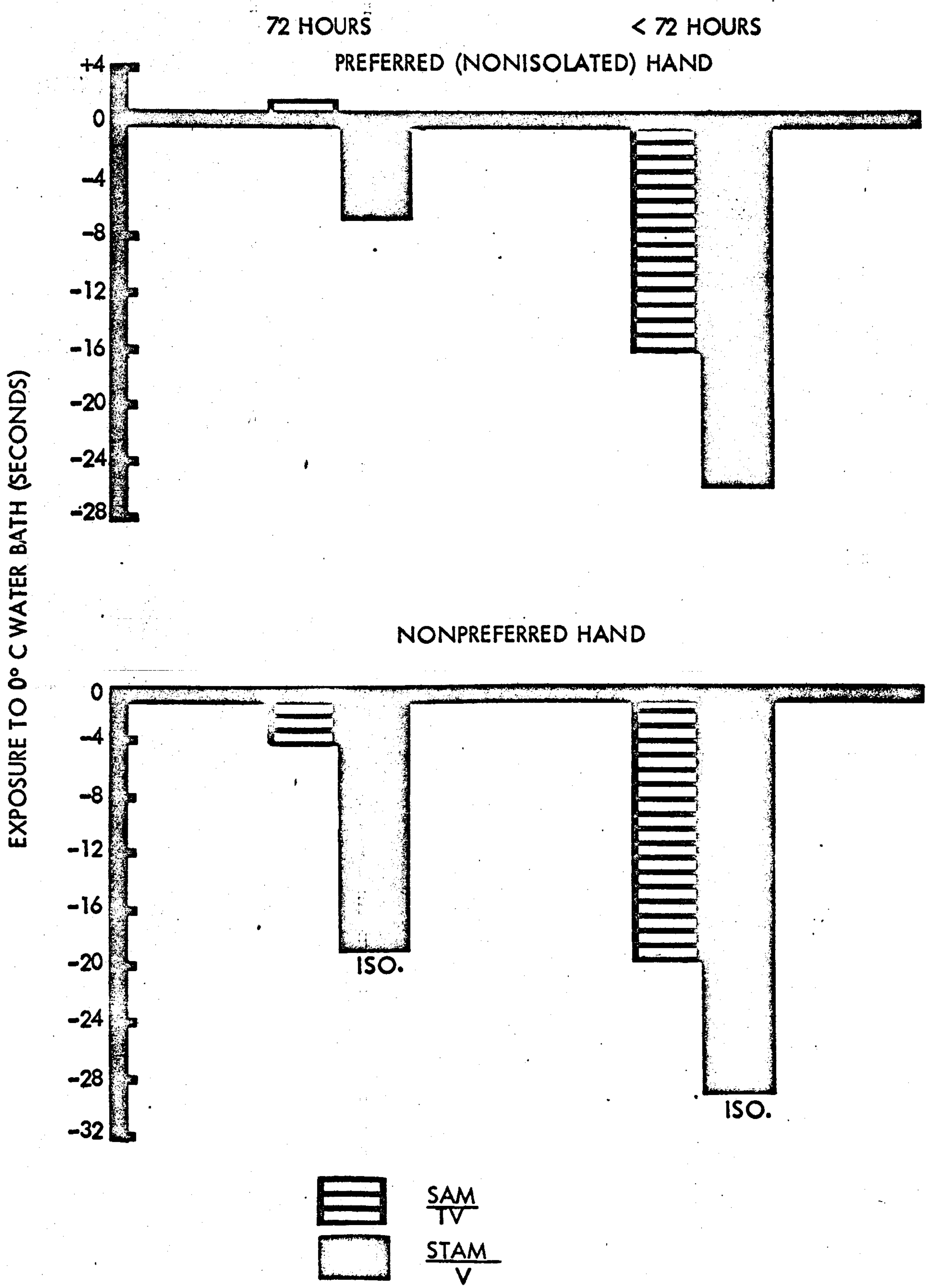


FIG. 25. PAIN TOLERANCE.

Mean Post- Minus Preisolation Differences.



Additionally, comparisons with the control group and the total SD group must await the completion of these final analyses.

In spite of the above limitations, however, a number of interesting points may be mentioned. In the group with only vision available (STAM/V), the <72-hr. Ss seem to show results opposite to those of the 72-hr. Ss. Thus, the <72-hr. Ss showed marked improvement, compared to the 72-hr. group on Verbal Comprehension (Fig. 12), Space Visualization (Fig. 14), Time Estimation (Fig. 15, Average Deviation), Hand Strength (Fig. 16), and Absolute Pressure Thresholds (Fig. 18). In addition, they showed less decrement for Absolute Auditory Thresholds (Fig. 20), were more sensitive to pain (Fig. 24), and exhibited decreased hand temperature in contrast to the increase shown by the 72-hr. Ss (Fig. 10).

We are unable to explain these differences between the "quitters" and "stayers" at the present time. One possibility is, of course, that the differences reflect the differing number of hours spent in isolation. This possibility can not be ruled out, but it is interesting that the same subgroups within the SAM/TV group did not show these differences, or showed them in a considerably attenuated form. We will further investigate this possible relationship by plotting the changes as a function of the number of hours in isolation.

Another possibility is that the <72-hr. Ss performed below their capability on the preisolation tests, while their postisolation performance was "normal" and, therefore, appeared improved. To investigate the possibility that those Ss who actually remained for the full period differed initially from those who quit, we will, of course, determine the significance of differences in preisolation performance of the groups. However, assuming such differences exist, the question of the source of the below-normal performance would remain to be answered. One interesting speculation is that the <72-hr. Ss are "too greatly aroused" to perform well before isolation, but relax somewhat during isolation. Consequently, their postisolation test performance may take place while they are relatively calm, and may thus reach normal levels. Following this, however, another logical question would ask why the <72-hr. Ss left isolation early, since we have speculated that excessive arousal might lead to a request for early release. However, the preisolation "excited" Ss could calm down somewhat during isolation, but still be maintaining a high level of arousal. It may be that continued or cumulative stress over a number of hours is a crucial factor in early release. Examination of absolute basal skin resistance levels and EEG activity should help to resolve this question.

Visual Isolation*

In earlier progress reports we have described an experiment in which only vision was deprived. Briefly, the experiment was conducted as follows: except for blindfolding, the subjects led as normal a life as possible during the deprivation period. All isolation groups remained at the laboratory under continuous observation during their participation in the experiment. The 64 subjects were divided equally into eight groups. Half of the groups received a preisolation test battery, went through the experimental or control procedures, and then were retested at the end of 48 hours. The other four groups went through the same experimental procedures but were retested after 6, 12, and 24 hours, as well as at the end of the 48-hour period. Each subset of four groups comprised experimental groups with vision of the left or right eye occluded, an experimental group with vision of both eyes occluded, and a control group (no occlusion). In addition to the varied types of visual deprivation outlined above, this experiment gave us the opportunity to test a number of measures of visual performance which could not be included in an already lengthy list of tests employed in the main sensory deprivation test battery. Thus, in addition to brightness, difference thresholds for hue saturation, and curvature, and measures of recognition of verbal material, numbers, and geometric forms, were obtained, as well as a measure of acuity. These measures were obtained for the nasal and temporal fields of the right eye, to obtain an estimate of the effects of isolation on peripheral and on central mechanisms.

The results of this experiment have not yet been completely analyzed. However, an analysis of variance for each function has already indicated significant improvement for all experimental groups (as compared to controls), for acuity and for perception of curvature. Thresholds tended to improve in all experimental groups for brightness, and for perception of forms and numbers. Hue saturation thresholds showed no significant trends.

*This experiment was conducted by B. Dusansky, a graduate student at Yeshiva U. as a doctoral dissertation, under the sponsorship of Dr. Weinstein.

Visual sensations such as light and color flashes, spots, geometric patterns, etc. were reported by a majority of the experimental <u>S</u>s in almost identical frequencies for monocular and binocular occlusion groups. Reports of "seeing" flashes of color and amorphous shapes were restricted to a few subjects who were tested <u>during</u> isolation. The groups with continuous isolation, however, reported more "complex" sensations such as objects and people.

II. Equipment and System Development

Acquisition, testing and operational installation of various equipment systems has continued. The specific systems are described below.

Measurement of Skin and Chamber Temperature

Chamber temperature is now being monitored through the use of the Yellow Springs Instrument (YSI) Model 405 thermistor air probe and the YSI 44TJ Telethermometer. This system represents a large gain in accuracy over the previous method used to monitor chamber temperature. The skin temperature of the medial phalanx of the second finger of the nonpreferred hand of each S is now being monitored through the use of the YSI 426 thermistor probe and the 44TJ telethermometer. The thermistor is placed on the phalanx, and the lumen of a felt washer is centered over the probe. The lumen is filled with lamb's wool and the entire assembly is taped in place. A measurement of skin and room temperature is made once each hour.

Breathing Rate

Breathing rate is now being monitored by a short-time-constant (approx. 0.5 sec.) nasal thermistor. The thermistor (Thermonetics M713-143) is mounted in a small plastic tube which is placed within S's nostril. The air stream (both inspiration and expiration) partially passes through this tube, exposing the thermistor to a constantly varying temperature. Expired air heats the thermistor, lowering its resistance; inspired air cools the thermistor, raising its resistance.

The thermistor is connected across the input of the Grass 7P1 preamplifier, operating in the PGR mode. In this mode, a 50 μa constant current is passed through the thermistor, and the resistance changes, reflected as voltage changes, are then amplified. The amplifier is operated nonlinearly, i.e., it is overdriven so that the temperature changes caused by breathing produce a square wave output. This output drives a pulse-former, which operates a reed relay output. When the voltage of the inspiration-expiration curve exceeds a preset minimal level, the pulse-former closes the relay to ground.

The relay closure is the input to one leg of a 2-leg AND gate. The other leg of this gate is driven by the output of a recycling interval timer, allowing the gate to be opened for preset intervals of 0-30 minutes. Only when the timer is running can the pulses generated by S's breathing pass to an electromechanical counter.

The interval timer is presently being operated for a 15-minute period in each hour; therefore the counter tallies the total number of breaths taken in this 15-minute interval. Unfortunately, the system is still not entirely reliable, and further revisions are underway.

Heart Rate

A pair of NASA body electrodes is placed bilaterally beneath S's armpits on a horizontal line with his nipples. The signal from these electrodes is amplified by the amplifier-section of the Grass 7P4 preamplifier-tachograph. The amplified ECG drives a pulse-former AND gate-counter chain identical to that described in the breathing-rate section above. The counter tallies the total number of R-waves occurring in the 15-minute sample interval, rejecting other waves.

EEG

Seven NASA EEG electrodes are placed on S's scalp in the following locations: vertex, left parietal, right parietal, left temporal, right temporal, mid-frontal, and mid-occipital. The method of application of the EEG electrodes has been described in a previous progress report (Annual Report for period Sept. 1964- Aug. 1965). Bipolar recordings are taken between the vertex and each of the other six leads, using the amplifier sections of the Grass wide-band AC preamplifiers, Model 7P3. The amplified EEGs are fed into six channels of the Ampex SP 300 seven-channel tape system.

Auditory Tape System

Instrumentation has been acquired* to provide continuously available auditory stimulation, in the form of varied vocal and instrumental stereo music. The music is presented to S by means of a pair of Koss Pro-4 stereo earphones. Although S can not control the volume of the audio signal, a switch is provided to allow him to turn it off. A signal light at the monitoring station permits E to log the time during which the switch is on.

---

*Ampex Corporation donated a PR-10-4 stereo tape system and a number of prerecorded tapes. Additional tapes were donated by Radio Corporation of America.

III. Research Plans

(March 1 - August 31, 1966)

Data Analysis

1. The EEG frequency analysis will be completed on the data gathered during the total sensory deprivation experiment last year.

2. Statistical analyses of the test performances of subjects in the social-auditory-movement deprivation, and social-tactual-auditory-movement deprivation experiments will be completed. In addition, analysis of the EEG and GSR data from these groups will be initiated.

3. Analyses of data from experiments completed during this time period will be initiated.

Completion of Current Experiments

At the present time, an experiment is underway in which Ss remain in the isolation chambers for 72 hours without auditory, visual or tactual deprivation. Ss are provided with books and magazines to read, and music to listen to, but remain in social isolation, are not permitted to move about, and have their food intake restricted to bread and liquid diet. This group is intended to serve essentially as a control group for the effects of social and movement isolation in the absence of sensory restriction.

Visual and auditory stimulation is on an *ad lib* basis for these Ss. They are provided with a supply of paper-bound books and magazines, chosen by S before entering isolation, from a supply available in the laboratory. Auditory stimulation consists of tape-recorded music which is continuously available to S when he puts on the earphones present in the room.

Ss are tested with the same pre- and postisolation test battery employed in our earlier deprivation experiments. In addition, EEG, basal skin resistance, heart rate, and movement responses are recorded for 15 minutes out of each hour S is in isolation. It is anticipated that this experiment will be completed in May, 1966.

Experiments to be Initiated

Changes in physiological and behavioral measures during short-term sensory restriction. This experiment will be conducted in our laboratory by Robert D. O'Donnell, a graduate student at Fordham U., as his Ph.D. dissertation. In essence, the experiment will investigate the effects of relatively short periods of extreme restriction of movement and total sensory deprivation on reaction time, EEG, and basal skin resistance. The experimental design is outlined below.

Thirty male Ss will be subjected to one of three restriction conditions under two time periods while physiological and performance records are taken. The conditions are defined as: 1. "total restriction" in which sensory input is reduced in the visual, auditory, and movement-related senses, 2. "motor restriction" in which the movement-related senses alone are restricted and 3. "ambulatory control" in which S remains relatively unrestricted. For each condition, there will be a "short" subgroup (seven hours and 20 minutes) and a "long" subgroup (10 hours and 20 minutes). EEG records will be obtained from the occipital and dominant temporal regions. Basal skin resistance records will also be taken.

Each S will be required to respond, while in his restriction condition, to three series of auditory disjunctive reaction tasks: a preliminary series, a midrestriction series, and a series at the end of restriction. From these tasks, reaction-time latencies, correctness of reaction, and physiological correlates of correct and incorrect responses will be determined. Data on the cortical evoked potential produced by the first (nonresponse) auditory stimulus in each pair will also be inspected.

Specific hypotheses are based on the overall hypothesis that if short-term sensory restriction is accompanied by relatively severe reduction in the movement-related senses, effects will be produced which are similar to those seen in long-term restriction without such impairment.

At the present time a contour couch has been installed in one of the cubicles. Instrumentation for the auditory reaction-time test has been completed. It is expected that the experiment will be initiated within a few weeks, following the testing of several preliminary Ss.

Perceptual deprivation. We have stated in earlier reports that there are indications in the literature that total deprivation of stimulation may not be as disruptive as continuous, nonpatterned stimulation within a sensory system. The latter paradigm is called "perceptual deprivation." We are presently developing instruments for an experiment in which Ss will undergo 72 hours of perceptual auditory, visual and tactual deprivation.

The experiment will be initiated upon completion of the current experiments: social isolation and movement restriction, and short-term sensory and extreme movement restriction.

Experiments Under Preliminary Consideration

Cortical evoked potentials (CEP). Preliminary work on CEP has been undertaken during recent months. Thus far, we have instrumented and successfully tested the auditory and visual stimulation systems. Initial work with the recently developed microesthesiometer has been very encouraging. However, a number of mechanical problems have arisen, which are being worked out with the manufacturer of the instrument. Paramount among these problems has been the attempt to eliminate airflow around the air deflectors between trials, at the high pressures used in producing CEP.

A fourth stimulation system, electric shock, is presently under investigation. A number of shock sources have been tested and were found to block the EEG amplifiers, thus precluding any analysis of the CEP. We are continuing the investigation, and have requested from two companies demonstration models of battery-powered models.

The experimental analysis of CEP in isolation is not contemplated during the current period. However, some indication of CEP to auditory stimulation, and its time course during up to 10 hours of deprivation will be available from the movement restriction experiment, described above. These data will be of value in designing future CEP experiments, e.g., deciding whether stimulation should be introduced during isolation, or only as a postisolation test, etc.

Sensory rearrangement. Formal plans for continuation of our research on sensory rearrangement have not been completed. However, during the summer a number of NSF high school fellows, and medical fellows are normally assigned to our laboratory, and we plan to utilize them in sensory rearrangement experiments. One possibility is the investigation of the effects of wearing prisms for a few hours every day for a series of days. Another design under consideration is a daily session of a few hours of sensory deprivation (e.g., blindfold or ear occluder) followed by a sensory rearrangement situation.

IV. Grant Administration

Personnel

During the first six months of the grant, the research staff remained essentially unchanged from last year. There was some turnover in research assistants, and a reduction of staff to accord with budget requirements.

S. Weinstein, Ph.D., Principal Investigator and Research Associate Professor
M. Richlin, Ph.D., Research Assistant Professor
M. Weisinger, A.B., Research Assistant Instructor
C. Schulman, Ph.D., Research Associate (part-time)
L. Fisher, A.M., Research Associate
B. Silverberg, A.B., Research Associate (part-time)
I. Black, A.B., Research Assistant
D. Bricker, A.B., Research Assistant
K. Gorny*, A.M., Research Assistant
M. Horn*, A.M., Research Assistant
M. Kaplan, A.B., Research Assistant
I. Merson*, A.M., Research Assistant
S. Rosen, A.M., Research Assistant
A. Salazar, A.B., Research Assistant (part-time)
P. Smith, A.M., Research Assistant
C. Yerre, A.M., Research Assistant
I. Levine, Research Technician (part-time)

Film Report on the Sensory Deprivation Experiments

A film (16 mm., color) was produced at the end of the last grant year describing the sensory deprivation experiments. The original version of the film was presented at the Ames Research Center in October, 1965.

Subsequently, the film was further edited, a narration prepared, and sent to Dr. Stanley Deutsch, NASA, Washington, in order to have a copy with a sound track prepared. Dr. Deutsch will forward a copy to Dr. Trieve Tanner, at the Ames Research Center.

* Resigned during the report period

Attendance at Conventions

1. American Psychological Association, Chicago, Ill., Sept., 1965. S. Weinstein* and M. Richlin* attended.

2. Academy of Aphasia, Niagara Falls, Canada, Oct., 1965. S. Weinstein attended.

3. Psychonomic Society, Chicago, Ill., Oct., 1965. S. Weinstein and M. Richlin attended.

4. Society for Psychophysiological Research, Houston, Texas, Oct., 1965. S. Weinstein, M. Richlin, M. Weisinger* and B. Silverberg* attended.

5. Eighteenth Annual Conference on Engineering in Medicine and Biology, Phila., Pa., Nov., 1965. M. Weisinger* and B. Silverberg* attended.

Visits to Laboratories and Institutions

1. NASA Ames Research Center, Palo Alto, California, Oct. 6, 1965. S. Weinstein and M. Richlin presented report and film on sensory deprivation research. Informal discussions were held with various members of the Ames staff.

2. Dr. L. Morell and Dr. E. Donchin, Dept. of Neurology, Stanford U. Med. School, Palo Alto, Calif., Oct. 7, 1965. S. Weinstein and M. Richlin toured the laboratory and observed their techniques for obtaining and analyzing evoked potentials.

3. Dr. M. Rosenzweig, Dept. of Psychology, U. of California, Berkeley, Calif., Oct. 8, 1965. S. Weinstein and M. Richlin toured the department's laboratories and discussed the research on differences in brain chemistry as a result of an experience-enriched environment in contrast with an isolated and impoverished environment.

4. Dr. T. Frazier and Mr. J.L. Day, Crew Systems Division, NASA Manned Spacecraft Center, Houston, Texas, Oct. 17, 1965. S. Weinstein, M. Richlin, M. Weisinger and B. Silverberg discussed problems in long-term recording of electrophysiological responses from human Ss. Arrangements were made for applying to MSC for a supply of their EEG and ECG electrodes for our research.

4. Fordham U., Bronx, N.Y., Oct. 27, 1965. S. Weinstein addressed the monthly meeting of Sigma Xi, discussing research on sensory deprivation.

Visitors to Neuropsychological Laboratory

1. Dr. G. Ettlinger, Maudsley Hospital, London, England, Nov. 8, 1965. Dr. Ettlinger toured the laboratory and met with the staff. He critically discussed our research and informed us of current related research in various parts of the world.

* Travel expenses paid by funds from other grants.

2. Dr. R. Reitan, Indiana U. toured the laboratory on Dec. 1, 1965.

3. Dr. D. Giannitrapani, Institute for Juvenile Research, Chicago, Ill. toured the laboratory on Dec. 2, 1965. He discussed his methods for recording and analyzing the EEG phase differences between various brain locations (e.g., right vs. left hemisphere) with the staff.

4. Mr. G. Origlio, Department of Defense, Fort Belvoir, Va., toured the laboratory on Jan. 26, 1966. He discussed various research topics with Dr. Weinstein.

Miscellaneous

The following organizations have provided us with their product or equipment without charge:

Ampex Corporation; loaned a 4-track Stereo Tape System (PR-10) and 10 tapes for use in experiments involving auditory stimulation during isolation.

Arnold Bakers Co.; supplies and delivers on a weekly basis, all bread (Arnold Brick Oven White) for the isolation Ss.

Fairleigh Dickenson U.; provided operator and computer time for analysis of portions of the data.

Mead Johnson Co.; supplies and delivers, on a monthly basis, all liquid diet (Metrecal and Nutrament) for the isolation Ss.

NASA Manned Spacecraft Center, Crew Systems Division; supplied 40 EEG and 32 body electrodes for long-term recording. Electrode paste was also provided.

Radio Corporation of America; loaned 30 tapes for use with the tape system described above.